THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

MACHINERY

PUBLICATION OFFICES 140-148 LAFAYETTE STREET, CORNER HOWARD, NEW YORK

VOLUME 22 NUMBER 3 NOVEMBER, 1915 $2.00 A YEAR 20 CENTS A COPY

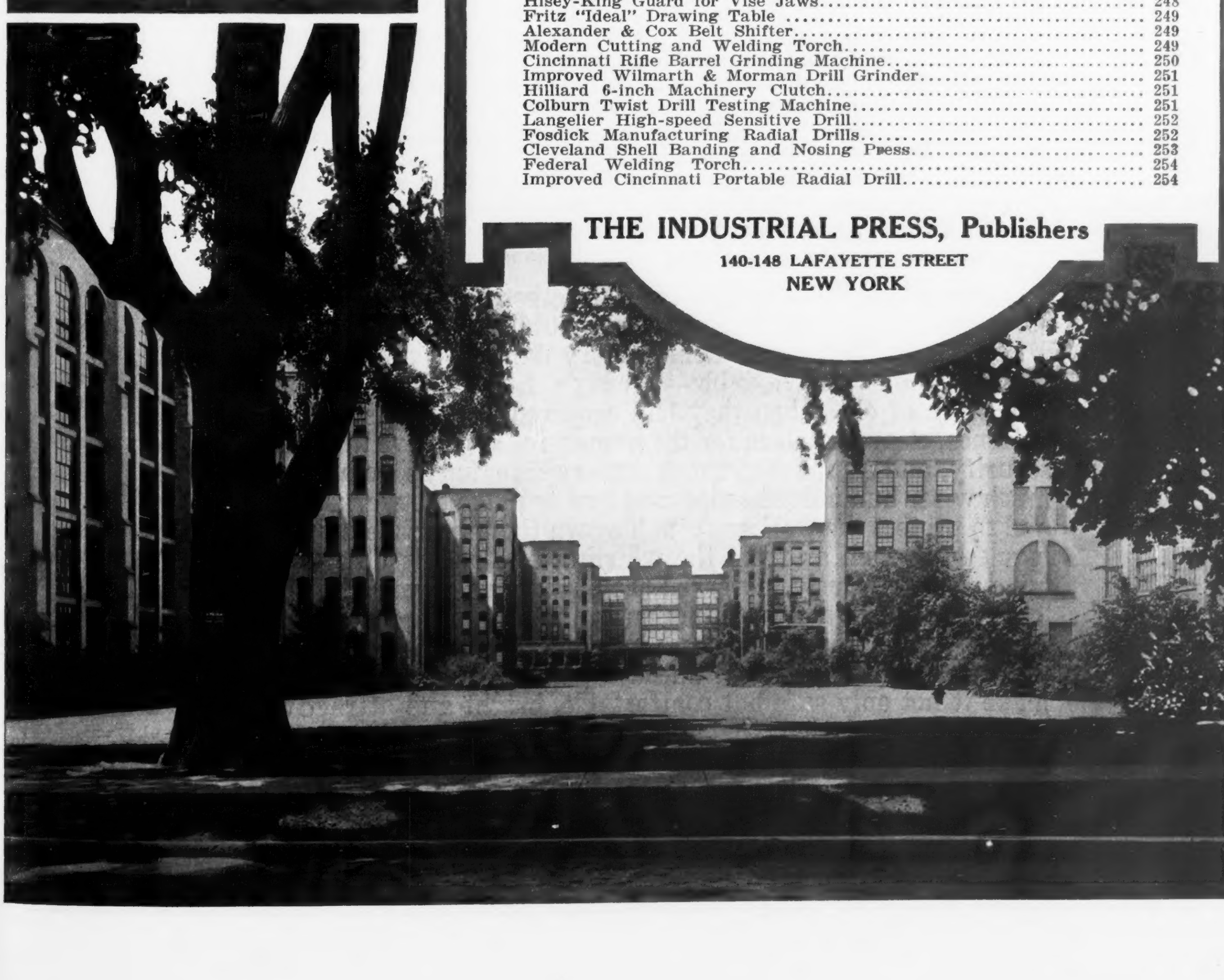
ADVERTISERS INDEX, PAGE 242—PRODUCT INDEX 228-240

CONTENTS

November 1915

Vol. 22 No. 3

THE INDUSTRIAL PRESS, Publishers
140-148 LAFAYETTE STREET
NEW YORK



The Modern Spirit in Industry

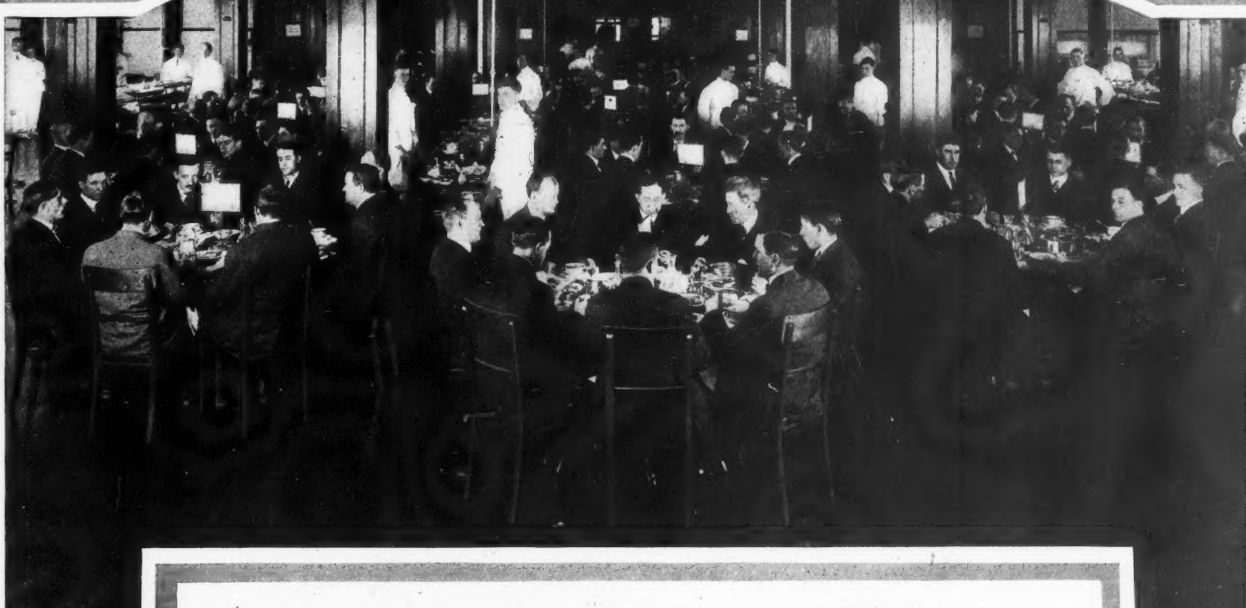
Slowly and painfully, through the centuries, humanity acquires knowledge and wisdom, which are two different things. How many primitive men had been crushed and clawed into eternity before a really effective bludgeon was fashioned for defense and offence in a wild and savage world. How many centuries had rolled by and what vast changes had been effected by ceaseless nature before the bow and arrow was invented—an instrument for humanity surpassing in effective power and precision the strongest and swiftest paw or claw in a world which was largely an animal world. Humanity's pace is faster now, but new dangers are found in the new combinations of powers and forces invented by progressive peoples, and the book of human knowledge and wisdom constantly needs new paragraphs to teach the new defenses.

How far we have traveled, and into what new dangers, let the following illustrate:—

> "Take the case of a large machine shop, and see what are the probable causes of one hundred accidents. It will usually be found that out of every hundred accidents, about twenty are caused by workmen falling or slipping, or are strains incurred while engaged in lifting. About fifteen are caused by falling weights or by objects tipping or slipping, and about twenty-five are incurred while using hammers, wrenches, chisels and various other hand tools. These three causes account for the great majority of accidents occurring in shops using heavy, high-speed machinery, and they account for nearly all accidents in other forms of industry. Of the remaining forty accidents, about five are caused by men being caught in moving parts which it is impossible to guard, about six are caused by men being caught in moving machinery where it is possible to guard the machine, and about six are caused by the use of emery wheels or other grinding and polishing machinery. About sixteen out of every hundred accidents are due to flying particles, usually chips of metal or pieces of emery, sometimes projected from machine tools or grinding wheels, and sometimes from chisels or other hand tools. About three accidents are caused by projecting nails or splinters, while the remaining four have miscellaneous causes."

The quotation is from the very interesting and comprehensive survey of Safety and Welfare Work published in this number of MACHINERY. For generations factory dangers were regarded as inevitable and unavoidable—nobody's fault. But just as the tribesmen of old, when they had acquired wisdom as well as experience, cleared a place for the human family to live in peace and security, and established the necessary safeguards, so a later and much wiser humanity has learned how to make the workshop safe, and to protect the worker from his own thoughtlessness and carelessness, as well as from the whirling and racing objects which have so marvelously increased the productive power of his labor. There is still greater satisfaction in the things that are done and being done for the worker as a human creature. A place may be safe, though unlovely and uncongenial. The modern spirit is to make it not only safe but comfortable, bright and attractive. It is on such foundations that civilization builds securely.

INDUSTRIAL BETTERMENT



A Study of Safety and Welfare Work in Manufacturing and Selling Organizations*

by

Forrest E. Cardullo †

The subject of industrial betterment has grown so greatly in importance during the last decade that no large manufacturer or other employer can afford to neglect it. The present article is the outcome of a careful study of all phases of welfare work from the point of view of both the employer and the employe. Inasmuch as the author is not engaged directly in industrial work he brings an unprejudiced mind to the task. He has covered in this comprehensive article safety and sanitation, housing of employes, cooperative organizations, profit-sharing systems, pensions, workmen's compensation and the many other ramifications of the subject. Those who are interested in promoting welfare work should find valuable suggestions in the work that others have accomplished.

ONE of the prominent features of our present-day industrial life is the amount of thought and effort which is being spent by many employers to further the safety, comfort, health and well-being of working people. This matter has become so prominent and so many employers are engaged in different phases of the work, that it has attracted great attention from employers, from social workers, and even from law makers. The National Civic Federation, for instance, has for some years maintained a department for the promotion of welfare work and many great employers of labor have created committees or boards for the same purpose.

So various are the activities which are included under the head of industrial betterment or welfare work, and so diverse are the methods favored by different employers, that there seems to the casual observer to be an entire lack of unity of purpose in the movement. Out of this kind of work has come a great national movement for the promotion of industrial safety. This movement has spread to practically all industries, and seems to be about the only phase of the work in which everyone is really united. The rest of the work appears to be sporadic in its nature. We see here an effort to make workrooms and factories more pleasant for employes, and there an attempt to provide better facilities for the midday lunch. One employer will lay stress on lockers and lavatory facilities, sanitary toilets and such matters. Another employer is equally outspoken in advocating a mutual aid association, and in supporting it liberally, so that the sick and injured may not suffer. Still other employers concentrate their attention upon the housing problem. Some others are earnest advocates of profit-sharing. No two firms seem to entertain the same ideas in regard to the needs of their working force, and there seems to be no broad underlying principle in the work which is being done.

The fact that welfare work appears in so many diverse forms, and the fact that each employer appears to go in for those forms that suit his fancy and practically ignores other forms, gives to the movement the appearance of a fad. Many men predict that the whole thing is a transient outburst of humanitarianism, and that it will die out in the course of time just as roller-skating, bicycling or tooth-pick shoes have disappeared, leaving as its only prominent mark upon our industrial history the movement for greater industrial safety.

It is hard for anyone to realize the true extent and tendency of the social movements of his own time. He can see nothing of the future and he is so close to the events of the

* For other articles on safety and welfare work previously published in MACHINERY, see: "Proper Eye Protection," December, 1914; "Organization for Safety," December, 1914; "State Laws on Accident Prevention," August, 1914; "Safety as Applied to Grinding Wheels," July, 1914; "Power Press Guards," July, 1914; "Norton Safety First Association," June, 1914; "Duplex Safety Tripping Device," May, 1914; "The Safeguarding of Belts, Shafts and Pulleys," March, 1914; "Progress in the Safety Movement," January, 1914; "Grinding Wheel Protection Devices," January, 1914; "Guards for Polishing Wheels," November, 1913; "An Analysis of Lathe Accidents," April, 1912; "Finger Guards for Wheelbarrow Handles," December, 1911; "Safeguarding Machinery," December, 1907; and "Guards on Machine Tools," July, 1907. See also articles referred to in foot-notes published in connection with these articles.

† Address: 48 Ashley Bldg., Lockport, N. Y.

present that things lose their perspective. Since everything is moving with him, he does not realize that there is any movement except the apparently senseless turmoil which he sees about him. Before we can appreciate the true meaning of this rapidly growing movement for industrial betterment, we will have to get a little farther away from it, and examine it in the light of recent historical development.

Brief History of Present-day Social Movements

During the Dark Ages it seems to have been the general opinion of mankind that society existed for the purpose of benefiting the nobility and clergy, and to protect them in the exercise of what they considered to be their rights. Government apparently was organized to confirm them in the privileges that they claimed and to so distribute and arrange their various privileges that they, as a class, might receive the maximum benefit therefrom. The peasants and serfs, who constituted the working population, might squirm and object a good deal, but their place in society was well known and thoroughly settled. Of rights and privileges they had none. In the eyes of the law and the "upper classes" they existed solely for the purpose of being exploited.

The invention of the printing press brought an end to the Dark Ages, and made modern democracy possible. With the advent of the printed word, the age of revolution began, a period which extends roughly from the beginning of the sixteenth century to the present. The age of revolution may be divided into four overlapping periods or phases. Following the introduction of printing came the religious and political revolutions of the sixteenth and seventeenth centuries. In this struggle the common people fought nominally for the right to freedom of worship, but the things which they really fought for were freedom of thought and freedom of speech. They were striving to liberate their minds and souls from the ancient thralldom of ignorance and dogma. While the struggle for freedom of thought and speech was still at its height during the seventeenth century, we find another struggle beginning in which the common people were fighting for the right to a more general participation in the affairs of government. This phase of the revolutionary movement is now approaching its conclusion. The period of political revolution was marked by a gradual extension of the suffrage and a gradual increase in the power of the representatives of the people, so that both the form and the spirit of government were radically changed.

Fig. 1. Exterior of the foundry of the National Cash Register Co. Attention to architecture and landscape gardening has made this foundry a beautiful building in an attractive setting. The cost is not prohibitive.

While the political revolution was at its height, at the very beginning of the nineteenth century, we see the period of social revolution commencing. This period is marked by the simultaneous development of two great movements. The first was a movement to secure for the common people not only the benefits but also the control of the great social agencies which had hitherto existed only for the benefit of the privileged classes. The second was a movement to so change the spirit and letter of the law as to make personal rights superior to property rights. In their attempts to secure for themselves the control of the social agencies, the common people developed a system of free schools and universities, and made provision of public libraries, hospitals, parks and other social agencies. In their attempts to create laws which would make personal rights superior to property rights they succeeded in abolishing the debtor's prison, in procuring laws regulating conditions of housing and conditions of employment, in reducing hours of labor, in gradually abolishing child labor and in making tenements and workshops safe and hygienic.

During the latter part of the nineteenth century we find the fourth phase, the economic revolution, beginning. It is the purpose of the economic revolution to secure a greater degree of equality in the distribution of economic welfare. The economic, like the social revolution, has developed two separate movements. The first movement attempts by law to limit the accumulation of great fortunes, to limit the profits of capital, and to improve the economic condition of the poor. Thus we have graduated income and inheritance taxes, regulation of public service corporations, minimum wage laws, workmen's compensation laws, old age and mother's pensions and other provisions looking toward a more equitable distribution of human welfare. The second movement is quite different in its nature. It attempts by organization and concerted action to secure for labor higher wages, shorter hours, and more favorable conditions of employment. The labor organization struggles directly with the employer. This phase of the economic revolution is of such great industrial importance and has to do so intimately with the matter of welfare work that it will be taken up later at greater length.

The age of revolution is a record of social advance. In it we see mankind progressing from tyranny to democracy, from ignorance to knowledge, from slavery to industrial freedom, from the bitterest poverty to comparative wealth. Nor can this improvement be attributed to any single social agency. Many agencies have combined in order to achieve the results we have observed. Sometimes these agencies have not been entirely harmonious, sometimes they have tended to counteract one another, sometimes the agencies intended to promote human welfare have been terribly destructive of that welfare. Always, however, the net result has been progress, progress in education, progress in methods of government, progress in industry and progress in human welfare.

Most of the social agencies to which this progress was due had a small beginning. They were not the ideas of any one man, but appeared here and there in different guises, making their way slowly against strenuous opposition. The ideas of different men underwent a period of consolidation and standardization before they became recognized as social agencies. We may consider, therefore, that the movement for industrial betterment is one of the agencies by which the social progress of the immediate future is to be carried on. It is not a transient movement nor is it a form of charity.

Nor when we come to study the situation do we find the movement so lacking in unity as we had thought. In the first place, the movement is new and it is difficult to tell just how it will eventually work out. In the second place, the local conditions of different industries vary so greatly that a line of action which may be successful and desirable

in one, may be useless and mischievous in another. A study of what employers are doing and how and why they are doing it brings the conviction that practically all the differences observed arise from differences in local conditions and are not due to serious lack of unity among those who take part in the movement.

When we cease to consider welfare work as a form of industrial charity, or a new method of increasing production, and consider it as one of the newest of the great social agencies for the promotion of human welfare, the subject takes on an entirely new aspect. Many of the so-called failures are explained. It becomes possible to see what lines of welfare work give promise for the future. It becomes possible to see the factors which will limit its extension in certain directions. It becomes possible to see the whys and wherefores of many recent industrial developments. But, most important of all, it gives us a new conception of the future industrial life. A century ago, industry was the instrument utilized by greed for the merciless exploitation of the working people. In the centuries to come, we see it infused with a spirit of humanity and democracy, and transformed into the greatest of all the social agencies for promotion of the general welfare.

Forms of Welfare Work

Welfare work may be roughly divided into two forms. The first deals with the physical condition of the factory and the conduct of the work itself. The second attempts to improve the community life. The first form of welfare work endeavors to make the factory a sanitary and pleasant place to work in, and, as far as possible safeguards the life, limb and health of the employe against accident and disease. An abundance of light, of pure air, and of good drinking water are provided. The working place is not only made safe and sanitary, but also as far as possible, pleasant and attractive. Every attempt is made to so order the environment and working conditions that the work will be healthful and pleasant, and the worker will reach the maximum of efficiency.

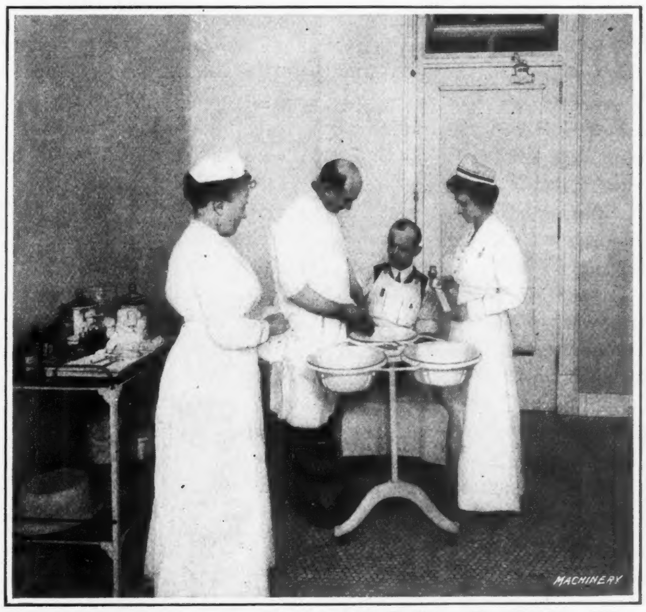


Fig. 2. Dispensary of the National Cash Register Co., Dayton, Ohio. The surgeons are treating one who has suffered from a slight accident. Prompt treatment prevents many cases of blood poisoning.

Having done all this, many employers feel that their duty is ended, but others realize that because of their relation to their employes and the community, because of the power which they can exercise through the possession of capital, and because of the executive ability which they command, they are in position to act as a social factor in the community, and to affect powerfully that part of the community life which has no immediate relation to its work. Many employers, for instance, realize that they are in a position to improve the standard of housing in the community, and to act in many other ways so as to promote community welfare. They realize that they have the power to make the town, as well as the factory, a more attractive and sanitary place in which to live, and to improve the lot of the women and children, as well as the workingmen. In consequence there is a growing tendency to extend welfare work into regions which have no direct connection with industry, and to make the factory an active agency in community development and community welfare.

Methods of Industrial Betterment—Improving the Workroom

It is in order at this point to turn from this general discussion of the origin, nature and purpose of welfare work, and classify and discuss the different lines of work that are at present in practical operation, leaving for separate consideration the matter of industrial safety.

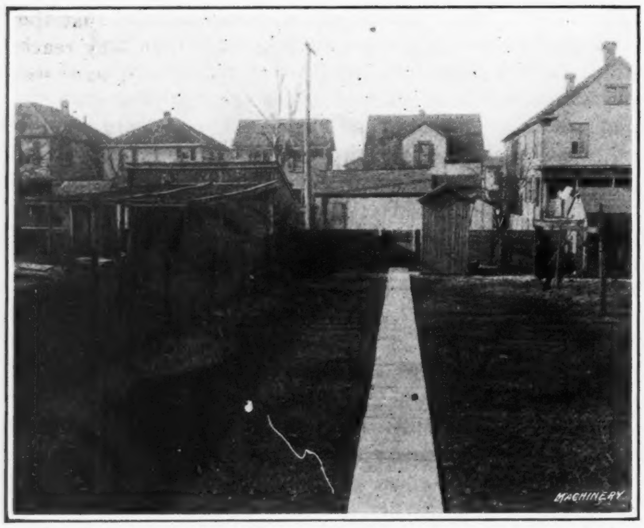
Since more than half of a workman's working hours are spent in the place in which he works, it follows that a decent regard for his happiness and welfare requires, first, that the workroom shall be a place in which the workman may reach a maximum of physical well-being and efficiency, and second, that it shall be as pleasant and attractive a place in which to work as is compatible with a reasonable cost of construction and the best working efficiency. In order to meet these requirements, it is necessary that they be kept in mind when the mill or factory is being constructed. In the first place, the floor space and head room should be ample so that there is plenty of room for every workman to move about at his task with a minimum of strain and fatigue, and without that cramped feeling which is engendered by crowded quarters. A certain prominent textile mill has two shops, one of which was built about twenty years ago, while the other has been in use for only a year or so. The machinery in the two shops is equal in every respect, but the output in the modern shop is 20 per cent greater than in the older one. This is attributed to the greater head room and floor space allowed in the modern shop, although the customary amount of room is provided in the older shop. The employes much prefer to work in the modern shop, and the experiment of providing what many would consider to be an excessive amount of room, has turned out to be thoroughly successful.

A second point to be considered in the construction of a shop is the provision of ample light in all those parts where men work. This means more than an abundance of window space or skylight area. It requires a proper proportion of head room to width of building; it requires a proper structural arrangement, so that beams and trusses do not interfere with the distribution of light; and it requires that the walls, and particularly the ceilings, shall be painted some suitable color. If the room is free from smoke and dust, white is suitable. If, however, there is much smoke or dust, white paint is quickly discolored and a light gray, slate or some other such color will be found to be superior. If the dark corners, the places under the benches, all the overhead work, the roofs, trusses, beams and so on, are of a light color and frequently painted, the more even distribution of light and the better illumination resulting, will pay for the painting and cleaning many times over by increasing the efficiency of the workmen and reducing loss due to accidents.

There is nothing better than an abundance of light for promoting cleanliness and order in the shop, and health and efficiency among workmen. Dirt and disease are born in the dark, cleanliness and health thrive only in the light. Light makes work easier; it acts as a physical and moral stimulant. So powerful is this effect that no indoor athletic record has ever approached the outdoor record for the same performance. Abundant light means health and contentment for the employe as well as dollars for the employer.

Cleanliness and Order

The provision of a spacious building and ample light well distributed makes for clean, wholesome and sanitary workrooms. Without intelligent and continuous effort, however, the best constructed workrooms will soon become dirty and disorderly, and quickly cease to be a sanitary and pleasant working place. It is therefore necessary to do more than provide a well constructed workroom. It is necessary to maintain it in a clean and orderly condition. In the first place, the ar-



Figs. 3 and 4. The National Cash Register Co. endeavors to persuade its employes to beautify their homes in the same way that it beautifies its factories. Fig. 3 shows a yard before planting and Fig. 4 shows what was done with the same yard as the result of the campaign for beautifying homes.

rangement of machines, benches and working spaces must be such as to promote an efficient and orderly progress of the work. Systematic methods of transporting the work from place to place, and of caring for the tools, jigs, fixtures and other accessories, must be employed. A properly equipped and supervised force of men must be organized for the purpose of systematically cleaning everything about the building. In the case of a new building, properly constructed, this phase of the work presents no difficulties. In the case of many old buildings, poorly constructed and ill-arranged, it is extremely difficult to make satisfactory progress in this matter. Not infrequently, when the wave of reform strikes a shop, the man responsible for creating a condition of cleanliness and order finds himself confronted by a dingy and ill-lighted building, with beams and tie-rods extending down into the working space, the floor piled high with stock, some of which has not been moved for months or even years, heaps of scrap iron here and there through which the workman must paw for bolts, nuts, straps and so on, dark corners in which are found piles of rubbish and litter, and a general condition of dirt and disorder. The first thing which must be done in such a case is to put the shop in order and to create a definite system for the moving of stock in process of manufacture, and for the storage of the tools, jigs and fixtures needed for the performance of the work, to provide tote boxes, waste receptacles, and so on, and then to provide the necessary organization to see that the good work is kept up. Not only is it necessary to clean the workroom, but the halls, stairways, toilets, walls and grounds must be kept in a clean and orderly condition. Especial pains should be taken to see that they are kept free from vermin and from breeding places for flies and mosquitoes. The toilets, washrooms, lockers and drains should receive special attention, and there should be nothing about a toilet or washroom which cannot be cleaned with a scrubbing brush and a hose.

In this connection it may be well to say a word regarding the old-fashioned idea of disinfection. The best disinfectant on earth is soap and water, and if extraordinary measures are required, a pound of chloride-of-lime dissolved in a pail of water. The use of patent devices for the purpose of dropping minute quantities of disinfecting fluids into toilets and drains is not only useless but positively harmful. A drain or toilet should be kept so clean that no odor from it is perceptible under any circumstances, and soap and water with the occasional use of chloride-of-lime is all that is necessary to accomplish this result. The patent disinfecting fluids are used in such small quantities that they have no effect except to produce an odor which hides the results of uncleanliness. If the use of one of the patent devices seems necessary in order to avoid disagreeable odors, it is evident that the plumbing is out of order, or that the janitor is not doing his duty.

Making the Factory Attractive

So far we have considered only the hygienic aspect of the factory buildings and grounds. There is another aspect of the matter which is worthy of serious consideration. Not only should the factory be a healthful place, but it should also be an attractive place in which to work. At first sight the beautification of factory grounds and the construction of pleasant and attractive workrooms may seem to be a matter of pure philanthropy, but it may be shown that even this phase of welfare work has its economic aspect.

I do not mean that the factory grounds should be made into beautiful parks (although the National Cash Register Co. does this very thing), and the workrooms transformed into art galleries, but rather that, so far as possible, all offensive features should be removed, and that a reasonable amount of thought and care should be spent in the arrangement and design of the buildings, the care of lawns, roads and walks, and in the architectural treatment of the factory interior.

It does not need the wisdom of Solomon to see that a workman who is placed in a dingy, ill-lighted and unpleasant workroom is presented by his employer with a constant incentive to quit. Neither is it difficult to see that a workman in a pleasant, clean, cheerful and orderly workroom, where the architectural treatment of the interior is as pleasant and attractive as is compatible with its purpose and a reasonable cost of construction, has a constant incentive to stay. The first man is forever dissatisfied with his work, the second is not.

It is difficult to estimate the economic value of pleasant surroundings. That such surroundings have an economic value is well attested by the fact that those of us who can afford to do so always attempt to secure them. Whenever we are able, we purchase a beautiful house and furnish it in such a way as to transform it into a beautiful home. We hire a landscape architect to arrange our lawns, our trees and our flower beds, because we realize that the pleasure and satisfaction which they give to us have a greater value to us than the money they cost. And not only do we do this for ourselves and our families, by beautifying our home and its surroundings, but as a community, we take pride in the appearance of our city, and tax ourselves to maintain a system of beautiful streets and parks for the whole people. In a thousand ways we acknowledge the economic value of pleasant surroundings, and the moral duty of providing such surroundings for those who are unable to secure them for themselves.

Too many of us, however, believe that beauty ends and utility begins at the factory gate. In the past many industries have been conducted on the principle that the cost of factory construction and operation must be the absolute minimum. This is a short-sighted policy, even from the economic viewpoint, for light, cleanliness and order increase the efficiency of the workmen out of all proportion to their cost, and the feelings of satisfaction and contentment which come to the workmen from pleasant and attractive surroundings, have a wonderful effect on the dividends. But laying such considerations entirely aside, is it not rather foolish for us

to tax ourselves millions of dollars for a park system which the workman can enjoy for only three or four hours a week, and then to provide him with an ugly and unpleasant working place, because it would take a few thousand dollars to render this working place decently attractive?

We often find the most important industry of a town in the midst of the most unpleasant surroundings. Frequently the grounds are enclosed by a high board fence, painted a dingy red. Rusty iron stacks belch huge volumes of black smoke to deface the neighborhood. Cheap shacks and vile tenements line every avenue of approach. Within, the shops are dirty, dark and disorderly. In such a case the workman comes instinctively to associate unpleasantness, poverty and filth with the industry in which he is engaged, even though he receives good wages and lives miles away in a decent neighborhood. Such unconscious associations have a powerful influence on a man's attitude toward his work and toward his employer. They foster friction and antagonism among the men. Such conditions make a fertile field for the labor agitator. They repel intelligent young men, and keep them from entering the industry. They act as a sort of sieve, which rejects the desirable labor element, and retains the inefficient, the discontented, the lazy, and the neer-do-wells. No such plant can prosper in competition with a plant which offers pleasant and attractive conditions of employment at the same wages.

Factory Ventilation and Air Conditioning

The problem of factory ventilation is, in many cases, a very simple one. Where the outdoor air is free from objectionable dust, and the workmen are not too thickly distributed through the factory, ventilation will largely take care of itself. When the workrooms are thickly crowded, but the work is clean, an abundant supply of air is easily provided by mechanical means. When, however, the nature of the industry is such that large quantities of dust or poisonous or disagreeable vapors are produced, the question of adequate ventilation should be the first consideration in the design of the factory. In such cases it is necessary to entirely remove all traces of the dust or vapors by withdrawing at certain places in the workroom an enormous volume of air. This air must either be cleaned and returned to the workroom, or it must be replaced by outside air, and if the volume of air so removed is very great, this kind of ventilation may become an item of considerable expense, both because of the amount of power required to move the air, and because of the amount of heat necessary to bring the entering air to the temperature of the workroom when the weather is cold.

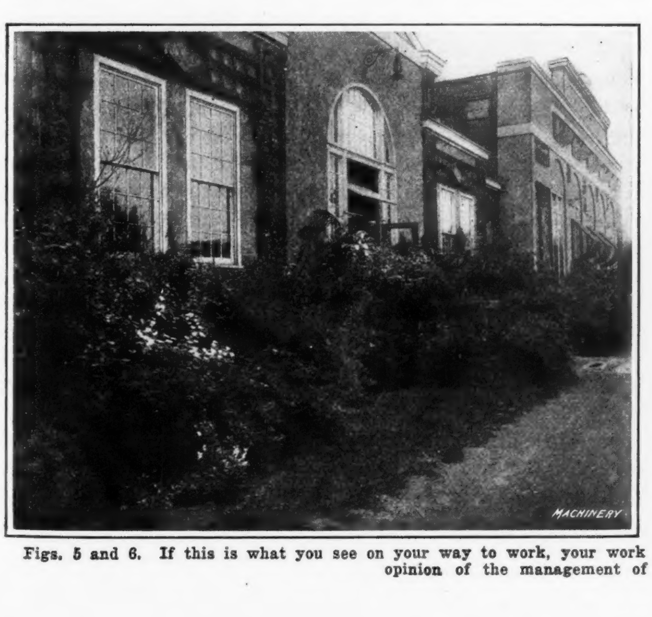
For many years it was thought that poisonous vapors were given off in the breath of human beings and animals. At first this poison was thought to be carbon dioxide, and when carbon dioxide was found to be harmless, it was thought that some unknown toxic substance must be given off in the breath. The most careful search has failed to discover such a poison, and we are forced to conclude that it does not exist. As a result of many years of scientific study of the principles of ventilation, we are now quite certain that foul air injures us for two reasons only: First, because it is hot and damp, and second, because it is loaded with germs and is therefore likely to give us disease. It has been definitely proved that if air is cooled and washed it may be breathed over and over again by a number of people without the least harm. The important things therefore are to have the air of the workroom of a proper temperature and humidity, and free from dust.

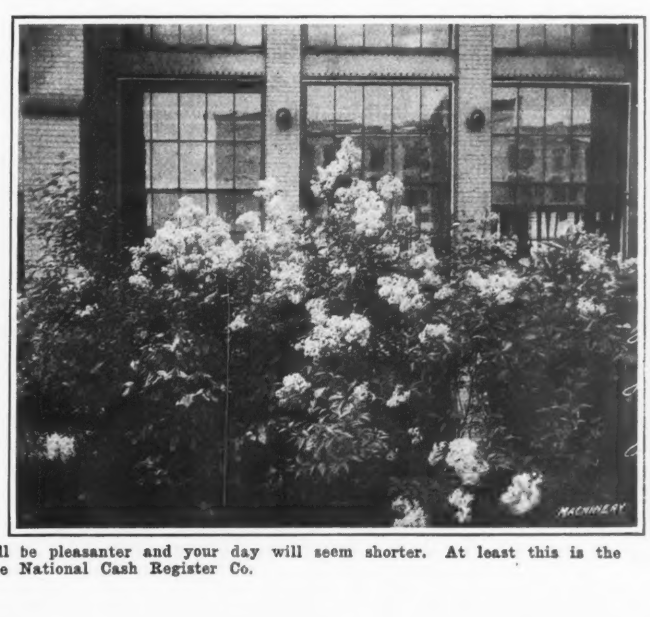
The human organism does its best work and is most comfortable and efficient when working in an atmosphere having a temperature of between 65 and 70 degrees F., and a humidity of about 50 per cent to 70 per cent. If the temperature or humidity rises above these figures, there is a decided loss in efficiency accompanied by a vague physical discomfort. At 80 degrees temperature and 80 per cent humidity, there is a loss of 50 per cent in efficiency in doing some kinds of work, and at higher temperatures this effect is still more marked. Not only does the efficiency of the workman fall off very rapidly with increasing temperatures, but the feeling of physical discomfort becomes almost unbearable unless a brisk breeze helps to carry away the heat of the body.

The body is cooled ordinarily by the evaporation of moisture from the surface of the skin and from the lungs. The cooler and dryer the air, the more rapid this evaporation, and the greater the quantity of heat so dissipated. The rate at which heat must be dissipated from the body depends upon the nature of the occupation, being least in the case of sedentary work, and greatest in the case of severe labor. If a number of people are in a closed room, the heat given off by their bodies soon raises the temperature, and the moisture evaporated increases the humidity, a condition of affairs which must be remedied by the introduction of a sufficient quantity of cool air.

Not only does proper ventilation maintain a proper temperature and humidity, but it also serves to remove foul odors which would make the workroom unpleasant, and the great quantities of germ laden dust which are given off from the bodies and clothing of the operatives whenever they are active. Every dust mote is the lodging place for a myriad of germs, some of which may be harmful. It has been shown in London that in those schools having no system of ventilation, the number of germs contained in each cubic foot of air was nearly ten times as great as where an adequate system of ventilation was provided. Clean air is much more important from a sanitary standpoint than clean floors, and a ventilation system is a method of obtaining clean air in the workroom.

Every industry sustains a considerable loss each winter because of the prevalence of colds and sore throats among its operatives. A part of this loss is sustained by the workmen themselves because of loss of time, but a still larger part is unquestionably sustained by the industry because of the loss





Figs. 5 and 6. If this is what you see on your way to work, your work will be pleasanter and your day will seem shorter. At least this is the opinion of the management of the National Cash Register Co.

in efficiency of men who are too ill to do their best work, and yet who are unwilling to lose time. Disease of this kind as well as many of the more serious diseases may be greatly reduced in amount by an adequate system of ventilation, and by maintaining the air of the workrooms in proper condition.

Nobody questions the necessity of warming the workroom during winter, and every shop makes ample provision for so doing. For some reason or other, however, we have greatly exaggerated the necessity of keeping a room warm during severe winter weather and entirely overlooked the fact that it is equally necessary to keep it cool at other times of the year. The systematic cooling of workrooms in hot weather, particularly in the South, ought to receive the same attention as the systematic heating in cold weather. The loss in efficiency and the effect on the health of the workman are just as serious when the room is maintained at 90 degrees as it is when it is maintained at 40 degrees. The time is not far distant when the intelligent and conscientious employer will realize this fact and in constructing his factory will make provision for keeping the workrooms cool and comfortable in summer, just as he now makes provision to keep them warm and comfortable in winter. It is possible, by means of suitable air-conditioning apparatus, to introduce into the workroom in hot weather air having a temperature of 10 degrees or even 15 degrees lower than that of the outdoor air.

By employing refrigerating machinery, it is possible to maintain any desired indoor temperature, no matter what the outdoor temperature may be. The employment of refrigerating machinery for such a purpose is probably too expensive a proposition to be practiced, but the use of air-conditioning apparatus capable of maintaining an indoor temperature of 80 degrees when the outdoor temperature is 95 degrees, supplemented by the free use of fans, has been demonstrated to be a paying proposition in several Southern shops. When the workroom is the most comfortable place in town, the worker will have no objection to spending his time there, and will not be so anxious for summer holidays. He will find his work less exhausting, he will be better able to enjoy his leisure hours, his health will be improved, and his efficiency will be greatly increased. The matter of air conditioning for the purpose of maintaining suitable shop temperature during the hot weather, is worthy of the serious attention of every employer interested in the welfare and efficiency of his employes.

In certain industrial processes large quantities of dust, or of disagreeable or poisonous fumes are liberated, which contaminate the air of the workrooms. Not infrequently such contamination produces serious occupational diseases, some of which are loathsome and deadly. In almost every case its effect on the general health of the workmen is easily observable, making them more readily subject to diseases of the nose, throat, lungs, and digestive organs. Examples of such industrial processes are dry grinding, buffing and polishing, stone cutting, the preparation of abrasives, electroplating, cement making, brass molding, and various chemical, textile and metallurgical processes. If such industries are not to be carried on at the expense of the health and even the lives of the workmen employed, provision must be made for removing the dust and fumes generated, before they have opportunity to do harm.

The only practical way to remove dust and fumes from the workroom is to withdraw from the room at the point where the dust or fumes originate, a large volume of air, moving at a fairly high velocity. This contaminated air may then be discharged from the building at some point where it will do no further harm. Such a system will be effective only when it is properly designed. The quantity and velocity of the air must be such as to completely remove the objectionable matter, and the system must be frequently inspected and intelligently operated. It is not enough to employ an apparatus capable of removing 90 per cent of the objectionable matter. The 10 per cent which escapes is still capable of deadly damage, and improvements in the design and power of the apparatus are usually all that is necessary in order to make it completely effective.

The grinding and polishing rooms of the Brown & Sharpe Mfg. Co.'s works are excellent examples of what may be done in the matter of dust removal. Each grinding or buffing wheel is partially surrounded by a suitably formed shield attached to a 4-inch flue, through which a large volume of air is drawn. The shield is so arranged that the dust generated by the grinding is discharged directly into the flue, and the design of the whole equipment is so excellent that not the slightest sign of dust may be seen in the air of the rooms.

Sometimes it is not possible because of the nature of the work to remove the dust or fumes which arise. A case in point is the process of "shaking out" after a heat has been taken off in a foundry. When it is absolutely necessary for men to work in an atmosphere laden with dust or fumes, respirators may be employed to protect the men against the ill effects which may result. In such a case, a great deal depends on the design of the respirator. If it is light and comfortable to wear and easily put on, the men will be glad to use it. If, on the other hand, it is hard to put on, or hot or heavy or uncomfortable in use, they will usually object to it.

Fig. 7. This beautiful building is devoted to the welfare, education and entertainment of the employes of the National Cash Register Co. It costs the company only a fraction of a cent per employe per day.

For some years we have had on the statute books of most of our states, laws granting compensation to workmen accidentally injured while they were working. For many years before that, it was a recognized principle of law that an employer was legally and morally bound to insure in every way possible the safety of his employes while engaged in their work. At present we do not have workmen's compensation for occupational diseases, nor has the law arrived at the point of requiring that every industrial process shall be conducted in the most healthful manner possible. In spite of the fact that the law is somewhat backward in this regard, every right-minded employer recognizes that it is his moral duty to see that every process in his factory is carried out under the most healthful conditions that can be devised. Whenever he can, by the provision of special ventilation or by changes in the methods of manufacture, render unhealthful conditions of employment more healthful, the employer is morally bound to do so.

Drinking Water

Just as important as the provision of a proper system of ventilation is the provision of an ample supply of good drinking water. A great deal of the water commonly used in this country is unfit to drink. A large part of it is polluted with sewage, surface drainage and decaying vegetable matter. It is a prolific source of typhoid fever, dysentery and minor digestive troubles, occasioning an enormous amount of sickness and great economic loss.

The drinking water used in a factory should if possible be procured from some uncontaminated source. If this is not possible, it should be purified before using it. Suspended impurities, such as mud, decaying vegetable matter and so on may be removed by mechanical filtration. Certain chemical impurities such as iron and sulphur, which make the water unpalatable, can be removed by chemical treatment. The greatest danger, however, is from disease producing bacteria which are found in many water supplies. These cannot be removed by mechanical filtration, and must be destroyed by some process of sterilization. One of the simplest and easiest methods of sterilization is to add a minute quantity of chlorine to the water, and then to permit it to stand in a tank until the action upon the bacteria shall have become effective. If the quantity used is just sufficient to effectively destroy the bacteria, it cannot be detected by the taste of the water, nor will any ill effects result from its use. Instead of using the chlorine itself, substances which give up nascent chlorine or oxygen when they are dissolved in water, are sometimes employed. Bleaching powder has been used in minute quantities for this purpose.

Fig. 8. Office buildings of the National Cash Register Co. The offices are as pleasant and attractive inside as the exterior of the buildings would lead one to expect.

Other methods of sterilizing polluted water are to treat it with ozone, which may be generated by a form of standard electrical apparatus readily obtained from dealers in electrical supplies; to subject it to the action of ultra-violet light in a rather expensive type of electrical apparatus; to heat the water to a boiling temperature for a short time and then to cool it; or to subject it to the so-called "slow filtration" which is a process of destroying the disease-producing bacteria by the action of other bacteria.

The question of whether or not the water supply is safe for drinking purposes can only be determined by periodic chemical and bacterial analyses. Such analyses are made, free of charge, by the board of health of every state. It is only necessary to request that such an analysis shall be made, in order to receive a container in which a sample of the water may be forwarded to the state laboratory of hygiene. A water supply which may be perfectly safe at some seasons of the year, may be dangerous at other seasons, and it is necessary to have both a series of analyses and a knowledge of the conditions at the source of the supply before it can be determined whether or not the water should be purified before it is safe to drink. If there is any question about the safety of the water supply, provision should be made for purifying it, as the cost of such purification is very slight compared with the great economic saving which results when it is effectively done.

Even though the water be drawn from a source of supply which is beyond suspicion, it may still serve to transmit disease. It may become contaminated by being contained in dirty pails or water coolers, and by being cooled with polluted ice. The common drinking cup also serves as a medium for the transmission of many communicable diseases, especially those of the mouth and throat. The most satisfactory way of avoiding these difficulties is by the so-called sanitary bubbling fountain which is rapidly coming into wide use.

Not only should the water supply be safe from the hygienic standpoint, but it should also be palatable and convenient of access to those who are to use it. The palatability of drinking water depends very largely upon the temperature. If the supply is not cold, the water should be cooled to a temperature of about 40 degrees by circulating it through pipes packed in ice. In order to avoid waste of water it is advisable to insulate the pipes by some covering such as is used for steam pipes, and to circulate the cold water through the entire system by a pump which returns the circulating water to the cooler. In this way cold water will run instantly from any drinking fountain, and it will be unnecessary for the workmen to allow a considerable quantity to waste in order to cool the supply. The fountains should be sufficient in number and so placed that every workman can find one convenient to his place or station.

While such provisions may seem to smack of luxury, it will be found that they are well worth while, both from the standpoint of the comfort and well-being of the employe and of the financial advantage of the employer. The purification of drinking water will eliminate a large amount of sickness, some of which is very serious and costly. The provision of an abundance of cold water, especially in summer, promotes not only the comfort but also the efficiency of the employe. The provision of sanitary drinking fountains will at certain seasons of the year reduce the number of cases of sore throat and other communicable diseases of like nature. Finally, the provision of an abundance of palatable drinking water serves to promote the general health and reduce the desire for alcoholic beverages, which is of great advantage to all parties concerned.

Lavatory and Sanitary Facilities

Thirty years ago the lavatory and sanitary facilities of the average industrial plant were crude beyond belief. Many plants were without sewage systems, and the toilet facilities were not only inadequate for the number of employes, but were also a menace to the health of both the employes and the community. In many shops the employe provided his own lavatory facilities, usually consisting of a tobacco pail, kept under a bench or in some dark corner. So numerous were these pails in one shop that they were used as fire pails on one or two occasions, with success. Since there were no coatrooms or lockers, the workmen wore their overalls to work, and hung their coats upon nails driven into some convenient post or wall. Mechanics usually returned from work with dirty hands and faces, and clad in old, often stained and ragged clothing. They did not do it from choice, but from compulsion. They felt that such conditions lowered the dignity

of their employment, and the community unconsciously assumed their employment was essentially inferior to those forms of work which permitted neat clothing and clean persons.

Some employers, perceiving that this state of affairs was unnecessary and objectionable, attempted to remedy it by the provision of proper sanitary facilities, by providing wash-basins with hot and cold water for the men's convenience, and by providing lockers or coat-rooms where their clothing could be taken care of during working hours. Their employes had an opportunity to return from work in good clothes, with clean hands and faces, and looking as respectable as any home-going bank clerk or lawyer. Since they were no longer ashamed of their appearance in public, they chose a better neighborhood in which to live, and the community speedily came to accept them as worthy followers of a dignified and necessary occupation. The workmen of such an employer ceased to be dirty laborers and became almost in a twinkling skilled mechanics and highly desirable members of the community life. The provision of lockers and wash-basins was a little thing, but it had an immense effect in improving the welfare of the men for whom it was made.

No sooner did the knowledge of such things begin to spread among workingmen in other shops than they began to demand that adequate and proper sanitary and lavatory facilities, lockers or coat-rooms and so on, should be provided in every shop. They insisted that they had a right to leave the grime of toil behind when they faced the public on their homeward way. They quickly saw that their improved appearance would secure for them a better understanding and a larger measure of public sympathy, in their other attempts to improve labor conditions. On the whole workmen have been very successful in their attempts along this line. There are few shops that do not make some provision of this kind, and in many states such provision is required by law.

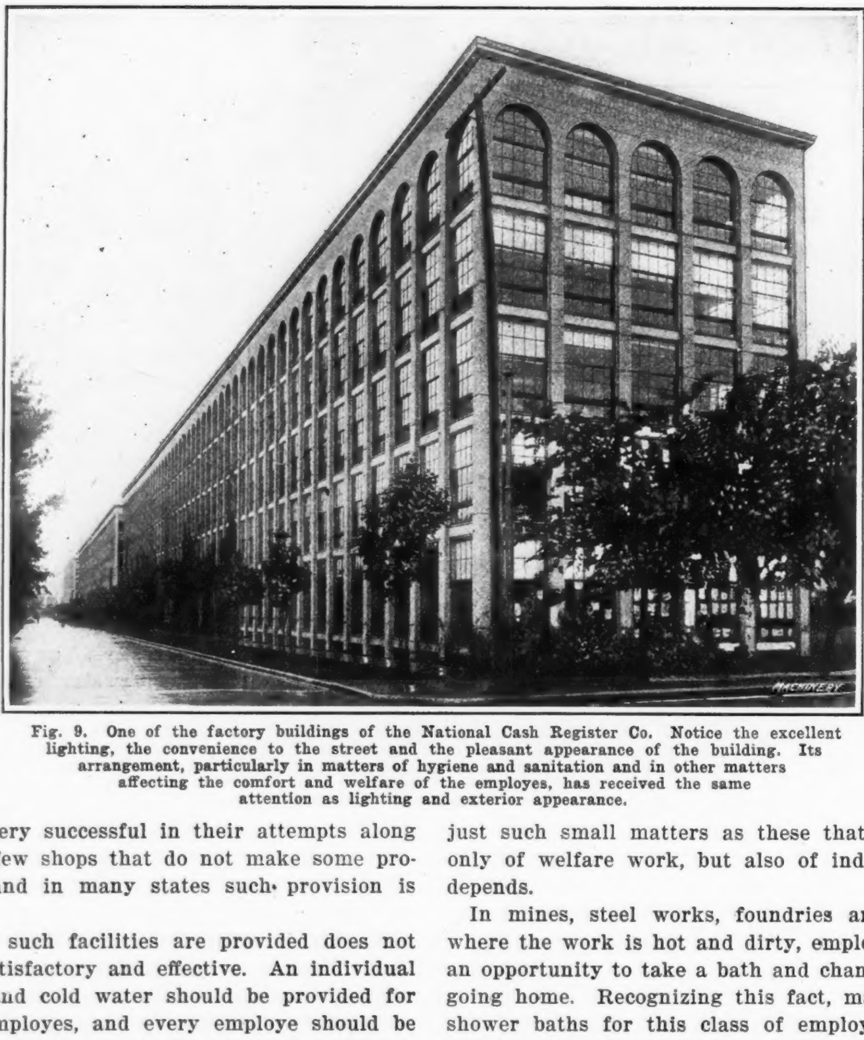


Fig. 9. One of the factory buildings of the National Cash Register Co. Notice the excellent lighting, the convenience to the street and the pleasant appearance of the building. Its arrangement, particularly in matters of hygiene and sanitation and in other matters affecting the comfort and welfare of the employes, has received the same attention as lighting and exterior appearance.

The mere fact that such facilities are provided does not argue that they are satisfactory and effective. An individual wash-basin with hot and cold water should be provided for every two or three employes, and every employe should be provided with a suitable place in which to keep his clothing. The arrangement of the locker and lavatory should be such that there will be no crowding and confusion at the closing hour. Especial care must be taken so that the men move in one direction only, as otherwise there will be delay and congestion. Apparatus which furnishes the hot water must have ample capacity so that the supply will not fail. The location of the lavatory should be such that the men will not have to go out of their way in passing from the workroom through the lavatory to the street.

Many firms, in an attempt to reduce the cost of the necessary installation, adopt unsatisfactory expedients. Frequently the lavatory is placed in dark and crowded quarters and the men have to enter and leave through the same door. The arrangement of wash-bowls and lockers may be such that men are continually obliged to crowd past each other in narrow passageways. Lack of room and improper arrangement of the lavatory or its inconvenient location may easily make a difference of five or ten minutes in the average time required by an employe to wash up and make himself presentable for the street. This is equivalent to asking men to work a few minutes over time every day without pay. Other unsatisfactory schemes are often employed which are intended to reduce the cost of installation. One is to provide cold water only for washing. Another is to provide a long trough in which a number of men may wash and which is filled with warm water just before closing time. By the time fifty men have washed in such a place, the fifty-first is likely to decide that he will go home dirty.

Not only must a lavatory be properly arranged and provided with suitable equipment, but it must also receive proper care, and the details of its administration are well worth careful attention. It must, of course, be kept perfectly clean. Since the lavatory is damp, a great deal of attention is required in order to prevent bad odors, nor is attention to cleanliness all that is advisable. Men are usually expected to provide their own towels and soap, but it frequently happens that they find themselves without these necessities because of forgetfulness or neglect. A great many firms are beginning to provide towels and to launder them at frequent intervals, usually twice a week. Many firms provide soap, while others keep a supply for sale. The intelligent conduct of the lavatory and locker-rooms is a matter of so much importance that it deserves more attention than it usually receives. The details of the arrangement and cleaning of the lavatory and locker-rooms, and the furnishing of soap and laundering of towels may seem to be small matters, but it is on just such small matters as these that the effectiveness, not only of welfare work, but also of industrial administration, depends.

In mines, steel works, foundries and many other places where the work is hot and dirty, employes appreciate greatly an opportunity to take a bath and change their clothes before going home. Recognizing this fact, many employers provide shower baths for this class of employes. This permits the men to return home clean and refreshed, and adds greatly to their physical well-being and their enjoyment of their leisure time. Some employers go further than this and provide a sufficient number of shower baths so that each employe may make use of them two or three times a week. This is an expedient of questionable value, however, as many employes find it more convenient to bathe at home than at the place of employment if the conditions of employment are not unusually hot and dirty. The community welfare requires that the employe shall have a suitable place to bathe at home, since the other members of his family must bathe there. If he has not such a place either there is something wrong with the community standard of housing, or else the wages paid are insufficient to secure proper housing. It is usually found that when bathing facilities are provided for employes not engaged in hot or

exceptionally dirty work, only a small proportion of the men make use of them, unless they are permitted to use them on the company's time. When all sides of the question are considered, this is not a matter for surprise.

Not even the most conservative of employers can question the necessity of closets and urinals. Even though some provision of this kind is made in every shop it is not always that the provision is satisfactory and effective. The toilets ought to be convenient to the workroom so that time is not lost unnecessarily in using them. The accommodations must be adequate for the number of men who are to use them, or else time will be lost in waiting. The toilets must be situated in well lighted and ventilated rooms, or they will soon become offensive. They must be so constructed that they may be easily and thoroughly cleaned, and such cleaning must be done in a systematic manner. There are sanitary and unsanitary varieties of toilet equipment on the market, and a wise choice of such equipment is imperative if the welfare of the employes is to receive due consideration. The sanitary closet seat, for instance, is quite as important a matter as the sanitary drinking fountain. This seat is cut away at the front and rear, in such a way that it is impossible for it to be soiled in use. The two halves of the seat are united and supported by suitable metal bridges, and the apparatus is quite as strong and satisfactory mechanically as a solid seat.

Providing Comfortable Working Conditions

It is one of the traditions of industry more honored in the breach than in the observance, that no man or woman should appear to be comfortable while he or she works. One of the rules formerly enforced in many department stores was that the clerks should always *stand* behind their counters, although it would be much more comfortable for them to sit when they were not actually engaged in serving customers. Some time ago a prominent machine tool firm published an advertisement in one of the technical papers showing an operator seated at his work in the factory. The man appeared to be seated on a soap-box, and the advertisement called attention to the fact that all the controls of the machine were within easy reach. It brought many letters both to the paper and to the advertiser protesting against permitting a man to sit at his work. In answer to these protests it was claimed that the man would not only be more comfortable, but also more efficient, when seated than he would be when standing, and the contention was unquestionably correct.

There are many kinds of work which can be done better by an employe who has a comfortable seat than by one who is compelled to stand. The assembling of small parts is a case in point, and workmen engaged in such a task are now usually provided with a chair or stool. One firm having a large number of employes engaged in such tasks, maintains that the construction and proportions of the chair used is a matter of great importance. Not only must it be of a comfortable design and properly cushioned, but it must be adjusted to the individual to get the best results. They point out the fact that even though such chairs cost $5 a piece, it is money well spent if the efficiency of the operative can be increased by even so little as one per cent. Even this very small gain in efficiency will pay for the chair in less than a year. They claim that experience demonstrates that variations in efficiency as great as 20 per cent may be occasioned by the use of different kinds of chairs or stools. This gain in efficiency is obviously accompanied by reduced fatigue and increased physical welfare on the part of the employes concerned. They cease their task at the end of the day less fatigued and better able to enjoy their leisure hours. Even though there were no gain in efficiency to be expected, a decent regard for the welfare of the employe should prompt the employer to make his work as comfortable and pleasant as possible.

In almost all kinds of work, efficiency is promoted by frequent but short periods of rest. The fireroom is a case in point. The fireman is continually engaged in work which is hot and laborious, and yet every few minutes he has a period of rest which makes his task possible. If he is compelled to rest himself by holding up the side of the building, his task becomes very fatiguing. A soap-box or stool will reduce the fatigue and make him more efficient. A comfortable chair, however, will do very much more. A somewhat different case is that of a man employed in operating a machine tool, and who has nothing to do for a large part of the time except to see that things go right. Custom decrees that such a man shall stand around or lean gracefully against the frame of his machine. Common sense asserts that he might just as well sit down and be comfortable.

Some tasks are disagreeable or uncomfortable because of their nature. A man may be obliged to work in a cramped and uncomfortable position, as in cleaning a boiler, or in certain kinds of erecting work. His surroundings may be disagreeable because of filth, vile odors, or extreme heat. A great deal can be done to relieve such conditions by changing the processes employed, or by adopting special expedients to overcome the objectionable conditions. The matter of abolishing uncomfortable working conditions is well worth careful study.

The two things which employes most frequently contend for in times of industrial strife are better wages and shorter hours. Better wages obviously mean to them, or at least should mean to them, better homes. Shorter hours mean less fatigue and greater leisure in which to enjoy those homes. The fact that workingmen are willing to fight for these things is sufficient evidence that they value them highly, and anything which an employer can do to improve their home conditions or give them greater opportunities for leisure is a kind of welfare work worth undertaking.

The location of an industrial plant and the arrangement of the buildings and exits are matters of great importance in this connection. Every industrial plant ought to be so located that the employes may easily and quickly reach a suitable residence district, and it ought to be so arranged that every workroom is easily accessible from the street or car line. A plant located in the midst of a business or manufacturing district and at a distance from a car line lays a heavy burden on the leisure hours of its employes. This is particularly the case when transfers and delays are necessary before a suitable car line can be reached, and when the cars are crowded so that many must stand. The time required for transportation between the home and the shop is just as truly taken from the employes' leisure hours as though it were spent at work. Not only so, but the conditions of travel may be such as to make this period much more fatiguing and disagreeable than an equal time spent in labor. It is all very well to have an eight-hour day, but if the employe is obliged to spend two hours of his own time in going to and from his work, his eight-hour day is not a matter of great profit to him. He might as well work ten hours a day in a plant adjacent to a pleasant residence section, and avoid the expense and fatigue of the long ride.

Whenever possible small and medium sized plants should be so located that their employes may find suitable housing within easy distance. In the case of large plants, the number of employes becomes so great that this is not possible. In such a case the question of suitable transportation should be carefully considered in locating the plant. A great deal may be done to assist employes in securing adequate and satisfactory transportation. Large plants invariably have railroad connections, and are in a position to arrange for special trains by means of which employes may quickly reach suitable residence districts. Arrangements may be made with traction companies by which suitable terminals may be provided on the company's property, so that adequate transportation facilities may be secured and at the same time unnecessary congestion and waiting at street corners may be avoided. Special cars may be provided to transport employes by the most direct route to different parts of the city so as to avoid unnecessary transfers and delay. Motor busses may be provided to serve districts not reached by street car lines, or to reach car lines which do not approach the plant. A common sense study of the transportation problem and a conscientious effort to solve it by cooperation between the employer and the transportation companies will often be of immense benefit to employes.

One of the most difficult problems encountered in connection with transportation is that of traffic congestion. In some plants, notably that of the Ford Motor Co. in Detroit, this is solved by having the different departments start and stop or change shifts at different hours of the day. One department may have a shift from 6 A. M. to 2 P. M., another from 7 to 3, a third from 8 to 4, and so on. It is a tremendous task to bring eight or ten thousand employes to a given point between 6:30 and 7 o'clock, but it becomes an easy matter if the time in which this task may be done be properly extended.

Not only must it be made easy for employes to reach their homes, but it must be made easy for them to reach the different buildings once they have arrived at the plant. I have in mind one large plant where every year one or two men were killed while coming to work for the reason that it was practically necessary for them to cross a railroad yard adjacent to the company's property, and in which switching was frequently going on. The only way for them to avoid this was to walk a distance of about two-thirds of a mile. The provision of an overhead bridge across this yard would have made a tremendous difference to more than half of the employes of this concern. Often they would be delayed while switching was in progress. Almost always they were obliged to climb cars in order to get across the yards. The company had it in its power to do a fine piece of welfare work, but at that time matters of the safety and welfare of employes received only casual consideration, and an investment of several thousand dollars in such an enterprise would have been regarded as out of the question. Today the United States Steel Corporation is spending millions of dollars in safety work of this kind.

In most plants no dangers are encountered within the grounds or about the gates, and yet often the gates, the walks and the exits of the buildings are so unintelligently planned that employes are caused to go a great distance out of their way in order to reach their working places. Usually such entrances and exits are planned solely with reference to the movement of material, and the needs of the employes are practically ignored. As a matter of fact, the movement of employes to and from work and in going about their necessary business should receive the same consideration as the movement of material. In large plants a great deal may be done in this way to save time and to eliminate unnecessary fatigue.

The approach to a factory may be pleasant or unpleasant. Of late years a great deal of attention has been paid to the condition of the factory grounds. Most firms content themselves with grading and seeding these grounds and taking care of the lawns thus produced. A few flower beds here and there are sometimes added in order to give a touch of color and improve the appearance of the lawns. Some firms, however, have gone much farther than this. The grounds of the National Cash Register Co. in Dayton, Ohio, are beautiful parks, and although this is a highly organized and efficient factory, its presence is unquestionably a material addition to the beauty of the neighborhood. A wealth of flowering plants, shrubs and vines are employed in beautifying the grounds, and the advice of a competent landscape architect is followed in this work. Many beautiful vistas appear between the principal buildings, and there is scarcely a window in the factory from which one does not view an exquisite landscape. Labor leaders have often argued that the money expended by the National Cash Register Co. in beautifying its grounds, ought of right to go to the employes in the form of increased wages. An investigation of the cost of keeping up these grounds, however, will quickly show that the possible addition to wages would amount to less than a half cent a day per employe. It is obvious that such a minute addition to wages would not be an adequate compensation for the loss of these beautiful surroundings.

The company claims, however, that it receives many intangible returns from the money expended upon its grounds, and that if the grounds were not cared for as they are wages would be lower rather than higher. In the first place, the grounds are a good advertisement for the company's product. In the second place, they serve to automatically select a high class of employes, that is, employes who appreciate nature and beauty, and who are, therefore, likely to have superior aspirations and desires in life. It gives to these employes the idea that their work is of a superior character to that performed in other less attractive shops. It leads them to desire to have the attractiveness of their homes and community conform to that of their factory. It leads them to spend their time and money in improving and beautifying their homes rather than in other and less satisfactory ways. It tends to select as employes men who are sober, industrious, thrifty, contented and efficient, and it intensifies these characteristics more and more as their employment continues.

Not only does this company beautify its grounds, but it makes these grounds convenient of access. No fences surround the grounds, and the streets of Dayton run through them with a car line on each side. Since the work is light, the buildings are several stories high. The employes are not obliged to climb stairs, but huge elevators take them to their proper floors, and everything possible is done to make the working place convenient of access, and to conserve the time and strength of the employes.

Medical and Dispensary Service

A form of welfare work which is unquestionably of great value is a system of medical inspection, supplemented by a dispensary service. At first sight this may seem to savor of paternalism, but in many kinds of work, such as the manufacture of food products and clothing, it is the public duty of the employer to institute such a service. In many other lines of work the welfare of the whole body of employes demands the detection and segregation of the victims of communicable diseases. In all lines of work, the interests of the employer require that the employe shall be at all times in such a state of health as to work efficiently.

A complete physical examination and subsequent systematic medical inspection is of great value among a force of employes for several reasons. In the first place, it serves to detect those employes who are physically unfit for their task, so that their work may be changed or a systematic course of treatment instituted which will restore them to normal health. A man with a weak heart, for instance, may be easily injured by performing some kinds of work. If he is given a suitable task, however, and a systematic course of treatment instituted, he may recover from his trouble in part or in whole. A man having incipient tuberculosis, who would be a danger to the public if employed in the manufacture of clothing or food products and to his fellow-employes if placed in a crowded workroom, may be given outdoor work in which he will have an opportunity to recover his health and strength. In such cases men having physical defects may be given tasks which are fitted to their physical condition, and which they may perform without detriment to the interests of their employers, their fellow-workmen or themselves. Without such medical inspection, they might become a source of danger to others and steadily exhaust their strength and vitality in the work which they are performing until finally their health is utterly destroyed.

Another advantage of systematic medical inspection is the fact that it discovers communicable diseases at an early stage, and makes it possible to take measures which will prevent their spread. This is particularly important when large numbers of young people are employed in any industry, as they are subject to many so-called diseases of childhood which are apparently harmless, but which often leave their victims with serious chronic organic diseases.

A third advantage of systematic medical inspection is the fact that it early detects the development of occupational diseases and makes the cure of such diseases possible by suitable hygiene and a change of employment, when otherwise they might progress to an incurable stage. This is a matter of especial importance in those industries known to be subject to such diseases. In every such case, systematic medical inspection should be performed at frequent intervals, and any

Fig. 10. Grinding wheels provided with suction hoods to remove the dust from the polishing wheels. This room is as free from dust as any place in the factory.

employe who is suffering from occupational disease should receive proper treatment therefor.

Of no less importance than systematic medical inspection is the dispensary service which is a part of the welfare work of many industries. In military establishments such service has long been considered an important element in promoting the efficiency of armies. A regular time is set apart when soldiers showing questionable symptoms are required to report at the hospital. Such practice is as important in promoting the efficiency of an industrial establishment as it is in promoting the efficiency of an army. The benefit of such dispensary service is felt in two ways. In the first place, the prompt detection and treatment of incipient illness reduces the amount of lost time, which is of benefit both to the employer and to the employe. In the second place, many slight illnesses which would continue for some time for lack of treatment, and adversely affect the efficiency of the employe for a considerable period, may be promptly cured by proper treatment and the employe restored to normal efficiency. Common colds, rheumatism, sore throat, boils, acute bronchial disturbances, indigestion and similar indispositions are easily controlled and quickly cured by prompt treatment. A man who is unwilling to take an evening off in order to visit a doctor, and in addition to pay him a fee, will willingly take ten minutes of the company's time to visit the dispensary and to receive free treatment.

Of even more importance than the treatment of slight illness is the treatment of slight injuries, such as cuts, bruises, and eye injuries. When not properly treated, this kind of injuries may become serious because of infection and subsequent blood poisoning. Prompt attention to them in the dispensary will save a great deal of suffering and subsequent loss of time.

Dispensary service cannot be considered to be a form of charity. It is rather a form of welfare work in which the employer and the employe may cooperate to their mutual advantage. The employer is more than paid for the expense of maintaining such service by the reduction in lost time and the increased efficiency of his employes. The employe is benefited because of his increased physical well-being and his greater earnings. The fact that the dispensary service is maintained at the factory saves the employe much time that would otherwise be lost in visiting a physician and in waiting his turn at the office. The fact that the physician's time is utilized efficiently enables the interested parties to secure a maximum of service at a minimum of cost. In the dispensary service, we have one of the best examples of what may be accomplished for the benefit of an industrial organization when full advantage is taken of the possibilities of cooperation.

In connection with the work of medical inspection and dispensary service, a system of collecting and tabulating sickness and accident statistics will be of great value. The collection and classification of information regarding illness and accident will lead inevitably to a systematic and effective study of the causes of illness and accident. Such information will point out the danger spots, detect unsanitary workrooms or residence districts, and disclose unsuspected sources of disease. It will show what safeguards are needed, and the lines of instruction that should be undertaken in hygiene and accident prevention. By studying the causes of accidents, we can eliminate dangerous conditions and improve our safety work. By studying the causes of illness, we may eliminate unhygienic conditions and improve the health of the workmen. Such a system of statistics will show very clearly the reduction in accidents and the improvement in health which result from systematic instruction and an earnest attempt to better conditions, which, in turn, will impress upon workmen the practical value of such work and thereby make it more effective. Since the collection and classification of such statistics promote the health, safety and welfare of the employes, it is

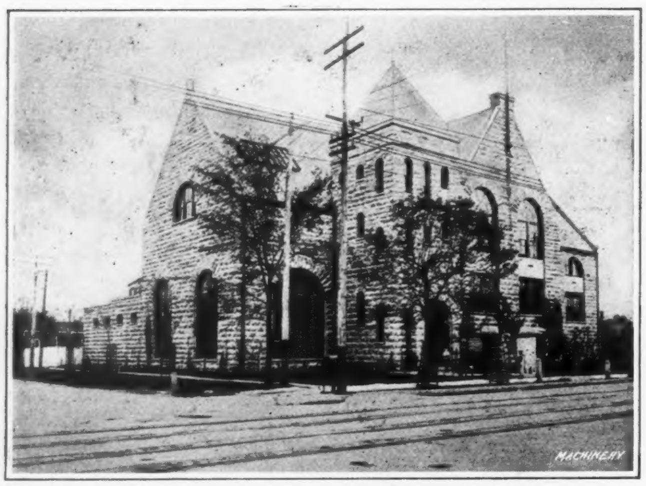


Fig. 11. This is not a church; it is the beautiful club house that the U. S. Steel Corporation has erected for the workers in its Joliet mills. It is a center of civic welfare.

just as important as similar work which is done by the cost department for an entirely different purpose.

The Lunch Problem

In the early days of American industry there was no lunch problem. The village blacksmith and his helper lived near the shop and went home to dinner. When the distance from the home to the shop stretched into a mile or two, they brought their lunch, which usually consisted of meat sandwiches, hard-boiled eggs, pies and coffee, in a two-story tin pail. The coffee was heated at the forge, or if there was no forge, over a bonfire. Fifteen or twenty years ago the two-story dinner pail lost out in its contest with the folding fiber box, and the coffee was replaced with cold water or beer according to the taste and habits of the owner of the box. The change was unfortunate. The new type of lunch was less satisfactory, nourishing and digestible than the old one. Nor is the modern factory a place as conducive to leisurely mastication and thorough digestion as the old blacksmith shop. Thoughtful employers began to consider ways and means of improving this situation, and particularly of providing an effective counter-attraction to the neighboring saloon that gave a hot frankfurter with a glass of ale.

Realizing that nothing is more effective than a hot drink in making a lunch palatable and combating fatigue, many firms provide a rack of steam pipes upon which the workman may warm coffee, tea and other liquids. A more satisfactory method is to furnish hot coffee or tea with milk and sugar to anyone who wishes it. In some places this is done without charge as at the works of the Larkin Co. of Buffalo, while in other works a small charge is made. A charge of ten cents a week is sufficient to cover the cost of this. Some firms go farther and provide a bowl of soup at a small cost, in addition to tea, coffee or milk to supplement the contents of the lunch-box. As a result, men and women find their lunches more appetizing, they take a longer time to eat, and the effect on digestion and efficiency is both marked and favorable.

A great many employes prefer not to carry a lunch. To meet the needs of this class of men, many firms have established lunch-rooms where a suitable meal may be obtained at a reasonable cost. This usually consists of meat, potatoes, bread and butter, tea, coffee or milk, and some form of dessert. The minimum price is usually fifteen cents. Sometimes soup and another vegetable are added, and occasionally the price rises to twenty-five cents. Often these lunch-rooms are conducted on the "take your choice and pay for what you get" plan, the employe serving himself. On such a plan the cost of a suitable meal is from ten to twenty cents for women, and from fifteen to twenty-five cents for men, who are usually more hearty eaters.

These lunch-rooms are sometimes operated by the firm without regard to profit. Sometimes they are operated by a co-operative association of employes, the firm donating the use of the necessary space and the kitchen equipment. Sometimes they are operated by private individuals for a profit. In most cases, when such a lunch-room is operated by the firm, the charges are insufficient to pay for the necessary material and the cost of cooking and serving the food. Very elaborate provision is sometimes made in this matter. For instance, the Pierce-Arrow Motor Car Co. of Buffalo has an enormous dining-room and about a thousand employes are served each day with a palatable and substantial luncheon at a cost of fifteen cents. Many firms who make no provision for male employes provide a dining-room for women employes.

In certain industries in which the operatives are liable to occupational diseases, the question of the lunch-room becomes an all-important one. A person working with poisonous materials, such as lead, may easily contract a case of poisoning by eating in the workroom. On the other hand, if such an employe has a separate place in which to eat, is served with proper food, and thoroughly washes his hands and face before eating, the danger of poisoning is greatly reduced.

Even when there is no danger of occupational diseases it is worth while both to the employer and the employe to see that the man has palatable and nourishing food and a suitable place in which to eat it. In a large plant, this requires a great number of chairs, tables and so on, and it is not usually attempted. There is no reason, however, why it should not be done, as the cost per man is very small and the results are proportional to the expenditure required.

It is often urged that workmen who are provided with suitable noon meals at a nominal price do not appreciate it. As a matter of fact, not all of them do. Some men feel that they cannot afford the price of a hot lunch. Others want the glass of ale that goes with the free soup and the hot frankfurters. It will be found, however, that a large proportion do appreciate it if the food served is to their liking. One difficulty has often been that the employer or the person responsible for serving the food has some fad which the workman did not appreciate. For instance, there are places where coffee is not served because the employer thinks it is not good for his men to drink it. One firm had considerable trouble because the man in charge of the dining-room was a vegetarian, and attempted to restrict the amount of meat consumed. Another firm found its efforts unappreciated because the menu consisted too largely of greens and similar vegetables. Workmen know what they like to eat, and they will not eat what they do not like. It will be found that a great deal of "lack of appreciation" is due to fads on the part of employers.

Fig. 12. Many of these little houses may be found scattered about the yards of the plant of the U. S. Steel Corporation.

Another frequent cause of "lack of appreciation" is a disinclination to eat at a second table. Men dislike to wait until thirty-five minutes past the hour for their dinner, when they quit work at twelve o'clock. When it is difficult to make provision for seating the entire body of employes in the dining-room at the same time, it may be arranged that some departments have their lunch hour from 11:30 to 12:30, while the others have their lunch hour from 12:30 to 1:30. In this way the men may be served promptly without waiting for half their number to finish.

A third reason for "lack of appreciation" is that the menu is often monotonous. The men get the same thing six days

a week and fifty-two weeks a year. Pot roast of beef and plain boiled potatoes pall on the appetite after they have appeared for the twentieth time. In an endeavor to secure a nourishing and easily digestible meal at a small cost, the manager of the dining-room often falls into the error of allowing the menu to become monotonous. If the men are to be satisfied and appreciative, an attempt must be made to give them some variety.

The lunch problem is probably the most baffling of all the problems connected with welfare work. In theory it is a fine thing to serve the men with a substantial and appetizing meal for a reasonable sum. This is an easy task for a hotel keeper, but not for a factory manager. It is a problem entirely foreign to his experience, and he bungles it. He is appalled by the magnitude of the task and the amount of equipment required, instinctively comparing his problem with the problem of administering his home kitchen. He fails to realize that its successful solution requires special knowledge and a high order of intelligence. He also fails to realize that the benefits derived are proportional to the magnitude of the task.

In considering the lunch problem, we must not lose sight of the fact that the greater the number of men to be fed the greater will be the beneficial results that will be accomplished. The mere fact that the task is large and that it requires a lot of gray matter to do it successfully should not deter us from attempting it. We have abundant evidence that when this work is well done it is worth while, and also that if we are not willing to devote the amount of work and thought necessary to make it successful, it is likely to be a most ignominious failure.

Profit-sharing

There are two problems which have always confronted the thoughtful employer of labor. They are "What constitutes a fair and just wage?" and "How shall I get my employes to take a real and personal interest in the welfare of my business?" Anything which offers a solution to these two problems will receive earnest consideration from such an employer. Apparently profit-sharing offers a solution to both questions. If the profits of an industry are divided with labor on a fair and equitable basis, the wage question settles itself. A knowledge that he is sharing in the profits of a business ought to lead a workman to take a very real and personal interest in the welfare of that business. Profit-sharing ought, apparently, to eliminate labor disputes, promote efficiency, and bring about a condition of prosperity and good-will.

The history of profit-sharing has, on the whole, been very disappointing. Companies engaged in profit-sharing have been no more free from labor troubles than companies not so engaged. Many firms have given up the idea after a lengthy experience with it. There are some cases in which profit-sharing has been a conspicuous success, but they are few in number. The methods which have been employed in apportioning the profits, and the reason this system has been unsuccessful are worthy of our careful study.

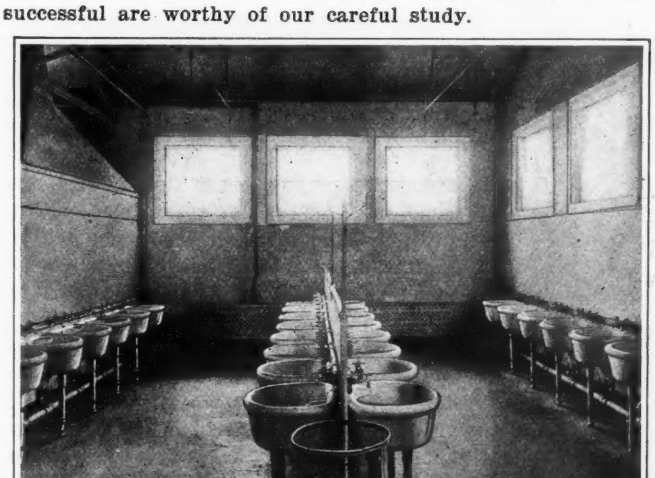


Fig. 13. The U. S. Steel Corporation believes that every man ought to have an opportunity to clean up before going home.

The simplest method of apportioning profits, and one which has often been used, is to pay each employe sharing in the profits the same per cent of his year's wages as is paid to the stockholder in the form of a dividend. Thus if a six per cent dividend is declared on the stock of the concern, every employe participating in the profits receives at the end of the year an amount equal to six per cent of his wages for that year. The division of profits is not necessarily deferred until the end of the year, but may be made quarterly or semi-annually.

A second method of profit-sharing divides the net profits of the business into two equal portions, one going to the stockholders, and the other to the employes. The half apportioned to the employes is usually divided in proportion to their earnings. Let us suppose that a firm having a capital stock of $500,000 has a wage roll of $1,000,000, and that the net profits for the year are $100,000. $50,000 of this is apportioned to capital, and the stockholders receive a dividend of 10 per cent. The other $50,000 is apportioned to labor, the employes receiving a dividend of 5 per cent of their wages.

A third method of profit-sharing is quite different from either of these. It assumes first, that labor is entitled to the current wage, and second, that capital is entitled to the current interest rate. After labor has received its wages and capital its interest, a surplus may remain. This surplus is then apportioned between the stockholders and the employes *in proportion to their earning power.* Thus if the current interest rate is 5 per cent, a man who receives wages amounting to $1000 per year has the same earning power as $20,000 worth of stock. (Strictly speaking, this is not true, if we recognize the fact that a man, like a machine, has a limited life and is therefore subject to depreciation. Allowance for depreciation reduces the value of a man's earning power by almost one-third. The introduction of this element of depreciation complicates the matter so greatly, however, that it gives the method an appearance of unfairness in the eyes of the average employe, and is best avoided.) The following case will illustrate the application of this method of profit-sharing. Assume that the wage roll for the year is $1,000,000, that the capital stock is $2,000,000, and that the total profits of the business are $320,000. Labor has already received the current wage. Assuming an interest rate of 5 per cent the $2,000,000 of capital stock is entitled to $100,000 in interest. The earning power of the employes, *i. e.*, their annual wages capitalized at 5 per cent, is $20,000,000. Adding the earning power of the employes to the amount of the capital stock, we have $22,000,000, upon which a dividend of $220,000 will be declared. This amounts to 1 per cent and, accordingly, the stockholder will receive a dividend of 6 per cent upon the par value of the stock, and the workmen will receive a dividend of 1 per cent upon their earning power, which will be 20 per cent of their annual wages.

If we assume that capital is entitled to 6 per cent in the above case, and capitalize the employes' earnings at the same rate, the capital stock will receive $120,000 in interest, and $200,000 will be left as profits. The earning power of the employes will be $16,700,000, and the profits will be 1.07 per cent of $18,700,000. The stockholders will receive a dividend of 7.07 per cent and the employes will receive 1.07 per cent of their earning power or 17.8 per cent of their wages.

The above forms of profit-sharing usually strike the average man as being not only fair but generous. But when we come to examine the results, we find that they do not solve the two all-important problems. Profit-sharing usually does not settle the wage question because there are not enough profits. After allowing a reasonable return upon the capital actually invested, the profits remaining are a very small proportion of the annual wage roll. When an employe feels that he ought to receive a substantial increase in wages, a six per cent "dividend" (which is all that he may reasonably expect in the average case) appears to him to be utterly inadequate. He is apt to feel that profit-sharing is simply a scheme to forestall a demand on his part for a just and adequate wage.

Nor does profit-sharing secure from the employes a real and effective interest in the company's welfare. A little extra pay

every three months, if it supplements a generous wage, may cause the men to wish the company well in its undertakings. But such mild and passive good-will is not particularly effective. The feeling of mutual interest must be stimulated to the point where it produces a noticeable increase in activity and efficiency. Profit-sharing usually fails to do this for several reasons. In the first place, the amount of the profits apportioned to labor is not sufficient compensation for the sustained activity and efficiency expected. In the second place, the length of time intervening between the activity and the reward is too great. In the third place, the diligent and efficient employe feels that he is obliged to share the profits which he has earned with the lazy and careless one. A system of profit-sharing is emphatically inferior to a justly administered piece rate or premium system, in securing active co-operation and increased efficiency on the part of employes.

There are still other reasons why profit-sharing does not awaken in the employe an unusual interest in the welfare of the business. The profits are usually equalized from year to year by accumulating a surplus during years of plenty, from which dividends and profits are paid during lean years. In such a case the employe feels that his efficiency has nothing to do with the profits which he will receive. The dividends will be exactly the same year after year, and extra effort will bring no reward. On the other hand, if all the profits are divided at the end of the year, there will be some years when there will be no profits to divide. The employe will then feel that it is adding insult to injury not to give him a dividend when, because of short hours and slack work, his earnings have been small.

If the profits realized in different industries were apportioned between capital and labor by any of the three schemes which have been outlined, it would be found that, in some industries, the portion available for labor would be exceedingly small, probably only two or three per cent of the annual wage roll. In other industries, the profits would be very great, sometimes being sufficient to double the employes' incomes. The unfortunate part of the matter is that as a general rule the profits are the smallest in those industries where the wages are the lowest. It will be seen then that profit-sharing not only fails to solve the two problems so often confronting the employer, but it also fails to settle the great social problem of a just distribution of wages between the industries.

There are a few industries of special character or in newly established lines of manufacture where the margin of profits is large, and where it is possible to pay unusual profits to the employes. The Ford Motor Co. of Detroit is a case in point. It makes a highly standardized product in enormous quantities, and sells it at a relatively low price for a good profit. In consequence, the profits of this company have been so great that an enormous plant has been created out of the surplus profits of the business, and at the same time the most liberal profit-sharing system of which we have any record has been installed. Mr. Henry Ford, the moving spirit of this company, believes that high wages are the best, most democratic, and the most practical form of welfare work. Accordingly he has established in the Ford plant a minimum wage of thirty-four cents per hour or $2.72 a day for the shop employes, and thirty cents per hour or $15 per week for all office help. In spite of this liberal wage rate, Mr. Ford's profits were still piling up. Accordingly he has made arrangements to divide these profits with his employes in the following manner: All employes who satisfy reasonable requirements as to efficiency in their work, and good moral character, and who, in addition, are twenty-two years of age and support one or more dependent persons, are eligible to share in the profits of the business. About three-fourths of the working force participate in this profit-sharing. The division of profits is such that everyone participating receives at least $5 per day of eight hours, while the maximum combined wages and profits for a shop employe is $7 per day of eight hours. Separate arrangements are made for profit-sharing with factory executives and office help.

It will be seen that Mr. Ford's employes participate in profits practically equal to their wages so that their incomes are about double the incomes of other workmen engaged in similar tasks. With such incomes it is possible for them to provide themselves and their families with satisfactory living conditions. An adequate income makes it possible for them to solve every social problem if only they have the character and intelligence to spend this income wisely. Unquestionably most of them do spend it wisely, although a not inconsiderable minority require constant instruction and guidance in order to keep them in the right path. There is an old saying that "Too much money has ruined many a man" and one of the social problems of the Ford Co. is to prevent the extra incomes from being so used as to prove a detriment rather than a benefit to a small class of employes.

From one point of view Mr. Ford's profit-sharing system is a huge success. The money distributed to the employes has, for the most part, been wisely used by them and has procured for them a much larger measure of social welfare than they could otherwise enjoy. However, there is unquestionably another side to the story. There are many industries which are more efficiently operated even than Mr. Ford's magnificent plant, but which would find it impossible by the most careful management to divide among their employes profits amounting to 10 per cent of their wages. These industries are so thoroughly standardized and so keenly competitive that there is a sharp and definite limit to their profits.

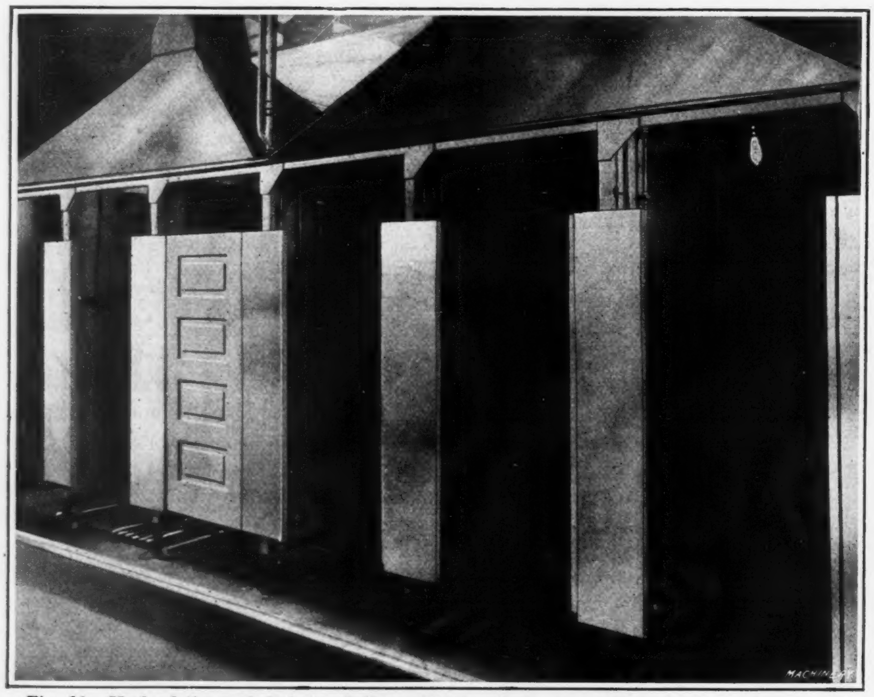


Fig. 14. Much of the work is hot and dirty. The employes may take a bath to cleanse and refresh themselves before leaving for home.

Some General Considerations

Profit-sharing is simply a method for increasing the income of the workers. It is no better and no worse than an increase in wages. It accomplishes nothing that is not accomplished better by other means in most lines of industry. When a number of companies are engaged in similar work and some of them, because of superior natural advantages, or of better equipment and organization, are able to make larger profits than the others, the general welfare requires that these efficient concerns should grow at the expense of the inefficient ones. In the long run, the workers of the industry in question are better served by a growth of the efficient plants and the disappearance of the inefficient ones, than they would be by a system of profit-sharing which permitted the survival of the inefficient plants.

When in any industry the workmen already receive a wage as high as is paid in any other similar line of industry, society is better served by a division of profits in the form of reduced prices or by the investment of the profits in other productive enterprises requiring capital, than by a division of the profits with the workmen. Social justice requires that our whole industrial system shall be so organized and conducted that the total amount divided among workmen in the form of wages shall be a maximum, and that the apportionment of wages among different classes of workmen shall be just and equitable. Since, as has already been intimated, the largest profits are available for distribution in those industries already paying the highest wages, profit-sharing takes from those who have not in order to distribute to those who have. Social justice demands a readjustment of these inequalities before profit-sharing is attempted. On the whole, the interests of society are best served by adjusting wages so as to make the incomes of different classes of workmen proportional to their industrial value, and by reinvesting unusual profits derived in any particular line of business in those productive enterprises which appear to promise the largest returns.

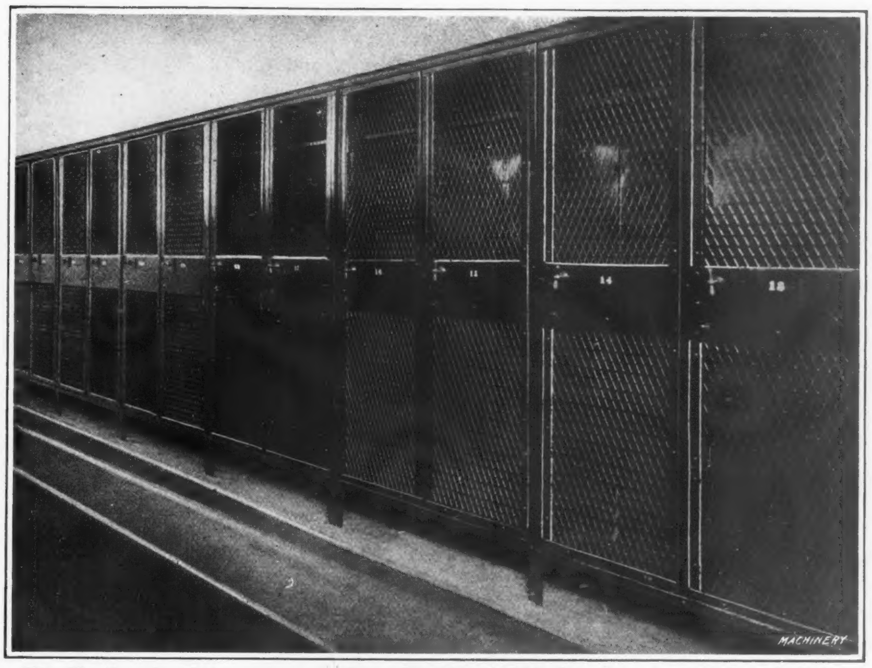


Fig. 15. In order that everyone may have clean dry clothes when they are through with their work, these lockers are furnished.

Safety Work

About twelve years ago America began to realize that preventable industrial accidents were a national evil of appalling magnitude. The agitation for workmen's compensation laws brought forth most astounding facts and figures in this connection. It was shown that both the number of accidents and the economic losses occasioned by them were increasing more rapidly than the output of our industries. It was shown that this loss was proportionately more serious in America than in Europe. As soon as the magnitude of the evil became fully apparent, a great safety campaign began. It has always appeared to the writer that self-interest has played quite as large a part in the spread of the "safety first" idea as altruism. For many years crafts unions had vainly demanded safeguards for machinery. For many years miners' unions demanded effective ventilation and drainage, and adequate timbering, and failed to get them. For many years we have had on our statute books various kinds of safety requirements which, although perfunctorily observed, were totally ineffective. As soon, however, as workmen's compensation laws transferred the burden of industrial accidents from the victim to the industry, the great "safety first" movement began. Under the stimulation of self-interest, national commissions, governmental bureaus, employers' organizations, and chambers of commerce began a serious study of the causes of accidents, the possible methods of preventing them, and the methods of minimizing the losses resulting from accidents.

The result of this work was another triumph for the scientific method when applied to the social and industrial questions. There is no question but what both conscience and self-interest have always recommended to workmen and to a vast majority of employers, a policy of accident prevention. There is no question but what a great deal of thought, time and effort had previously been expended in attempts to minimize or eliminate industrial accidents. But this work had previously been done in a haphazard and unscientific way, and was, in consequence, very ineffective. When self-interest entered as an ally of conscience and good-will, the methods of safety work underwent a great change. A thorough and systematic investigation was made of the causes of accidents. Then an equally thorough and systematic effort began for the elimination of these causes. By organizing the work, and by assigning responsibility for different phases of it, it was made more effective. A scientific study of industrial dangers was undertaken by government bureaus, and by private organizations. Finally there has resulted a full and free interchange of ideas through various engineering and industrial organizations and through the American Museum of Safety, which has made the work immensely more effective.

It is commonly assumed by those unfamiliar with the facts that the cause of the rapid increase in industrial accidents during the nineteenth century was the growing use of power-driven machinery, which was constantly increasing in size and weight and operated at speeds which appeared to be daily growing more dangerous. It was assumed that if this machinery could be guarded or changed in character or operated at lower speeds, or that if other and safer tools could be substituted for the dangerous ones, industrial accidents would be greatly reduced in number. This view of the matter has been shown to be very far from the truth. Less than one-third of all industrial accidents are caused by the use of machinery. Undoubtedly most of the failures among the earlier attempts at safety work were due to the fact that efforts were largely confined to safeguarding machinery, on the theory that machinery was the source of all the difficulty; whereas the real source was a prevailing spirit of carelessness among workmen and a lack of appreciation on the part of employers of the importance of the work and of the radical and thorough methods it was essential to employ.

It must not be inferred that workmen often consciously and voluntarily exposed themselves to danger. If they were given a task to do, they usually adopted for its performance the first method that suggested itself, and attempted to do the task in the most expeditious manner without considering possible dangers. The prevailing attitude of mind was "It is easier to take chances than to take time and trouble." Obvious and certain dangers were always avoided. The little things, however, like the frayed rope, the loose plank, or the insecure fastening received little attention. Of course all these things were attended to in the course of time, but they were often permitted to go uncorrected until an accident resulted. Chances were taken daily that ought not to have been taken, and danger spots were allowed to exist for a much longer period than was necessary.

The employer was equally careless in regard to such matters. His attitude of mind was expressed by the slogan, "Get out the work." The man who received his approbation was the man who "did things," meaning the man who accomplished results in a short time. The fact that such a man took unusual chances was regrettable, but it was the way of the world, and accidents were the price of success. Of course neither the employer nor the employe voluntarily permitted obviously dangerous conditions to continue indefinitely, but the danger usually had to be very obvious before the condition

was abolished. Both the employer and the workmen were unusually obtuse in the matter. Certain dangerous conditions which had existed from time immemorial were apparently sacred because of their antiquity.

This attitude of mind was reflected in the state of the law upon such subjects, which at that time held that while an employer was bound to carry on his work in a *reasonably* safe manner, reasonable safety did not require him to take precautions not usually undertaken in similar circumstances. In other words, he was not bound to abolish the danger spots if they were common in the industry. Unguarded gearing is a case in point. Such unguarded gearing was very common in certain types of machine tools, and was a frequent cause of painful accidents. Obviously guards were called for. However, since unguarded gearing was usual, the common law held that the employer was under no obligation to provide guards, unless they were required by some special statute or by some inspector or commissioner specifically authorized by statute law to make such requirements.

The real cause of the great growth of industrial accidents was the general acceptance on the part of both employers and workmen that these accidents were nearly all inevitable to the conduct of the business and that it was impossible to guard against or prevent them in any way. So long as this spirit endured, accidents were bound to become more and more numerous. Nor was the matter helped any by the well intended but unintelligent efforts often made by workmen to reduce accidents. The usual remedy proposed was to go slow, to take plenty of time, and to do everything in a safe, inefficient and ineffective way. There was no true appreciation of the causes of accidents and therefore no logical plan put forward to remedy the causes. The acceptance of the doctrine that accidents were inevitable was fatal to the cause of accident prevention work, and the continual failure of ill-considered schemes for accident prevention served only to fix the doctrine more firmly in the minds of all.

The first step in accident prevention was to explode this doctrine and to show that accidents were unnecessary. This could only be done by serious study of the causes of accidents and a willingness to invest time, money and brains in methods of accident prevention. Sentiment may make men anxious to abolish accidents, but only self-interest makes them willing to collect and classify accident statistics, to hire competent engineers to devise methods for accident prevention, and to spend a great deal of money in making these methods operative. That is why the beginning of effective safety work coincided with the introduction of workmen's compensation laws.

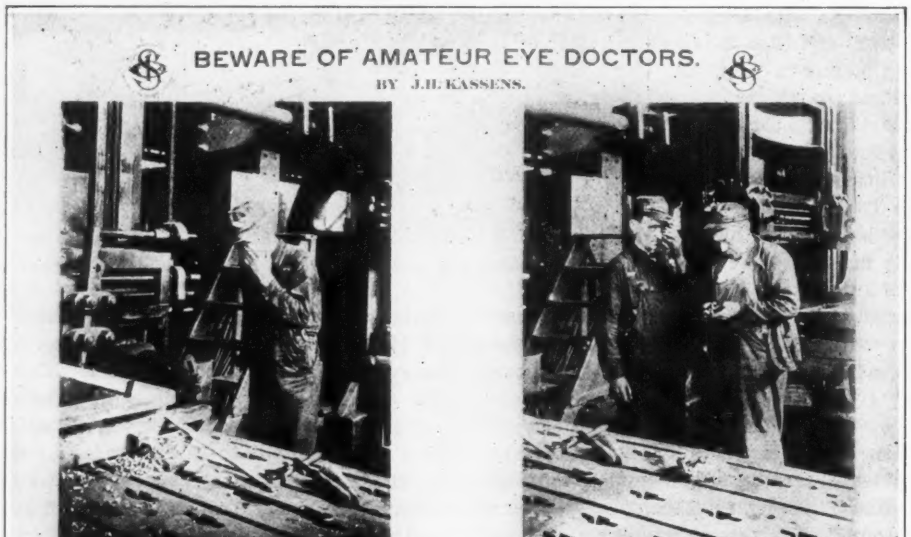


Fig. 16. Why some companies find dispensary service advisable

A Study of Accident Statistics

Accident prevention, like any other form of human endeavor, if it is to be successful, must be based upon a knowledge of facts. If we are going to prevent accidents, we must first know how and why accidents occur. If we have such information, we will be in a position to foresee how and why other accidents may occur, and we will also be in a position to devise effective safeguards. As an illustration of how accident statistics may be classified and studied, we will take the case of a large machine shop, and see what are the probable causes of one hundred accidents. It will usually be found that out of every hundred accidents, about twenty are caused by the workmen falling or slipping, or are strains incurred while engaged in lifting. About fifteen are caused by falling weights or by objects tipping or slipping, and about twenty-five are incurred while using hammers, wrenches, chisels and various other hand tools. These three causes account for the great majority of accidents occurring in shops using heavy high-speed machinery, and they account for nearly all accidents in other forms of industry. Of the remaining forty accidents, about five are caused by men being caught in moving parts which it is impossible to guard, about six are caused by men being caught in moving machinery where it is possible to guard the machine, and about six are caused by the use of emery wheels or other grinding and polishing machinery. About sixteen out of every hundred accidents are due to flying particles, usually chips of metal or pieces of emery, sometimes projected from machine tools or grinding wheels, and sometimes from chisels or other hand tools. About three accidents are caused by projecting nails or splinters, while the remaining four have miscellaneous causes.

An inspection of the above figures shows that one-quarter of the accidents are incurred while using hand tools. This suggests immediately an investigation and classification of the reasons for these accidents. What tools were the men using when they occurred? In what way were they using the tools? What were the contributing causes of the accidents? Let us suppose that we find that three of the accidents were caused by wrenches slipping. That raises such questions as these: What kind of wrenches were they? Were they defective? Were they being used properly? Were the nuts defective? Were the nuts too soft? Were the threads defective so that too much force was required to screw the nuts up? A careful study of this kind may suggest that the accidents occurred because the nuts were of poor quality, being too soft and improperly tapped so that the workmen had to exert a great deal of force. The remedy is to use better nuts. Or it may be found that the workmen were using wrenches which did not fit the nuts, possibly because the nuts were under-sized or slightly over-sized, or possibly the jaws of the wrenches had been forced open or the proper sized wrenches were not available. This suggests an improved pattern of wrench. We may, for instance, consider the advisability of using box wrenches of the ratchet pattern, to avoid this cause of injury.

Fig. 17. The U. S. Steel Corporation goes outside of its works in order to benefit the employes. A visiting nurse looks after the sick ones and does much to instruct the families in matters of right living.

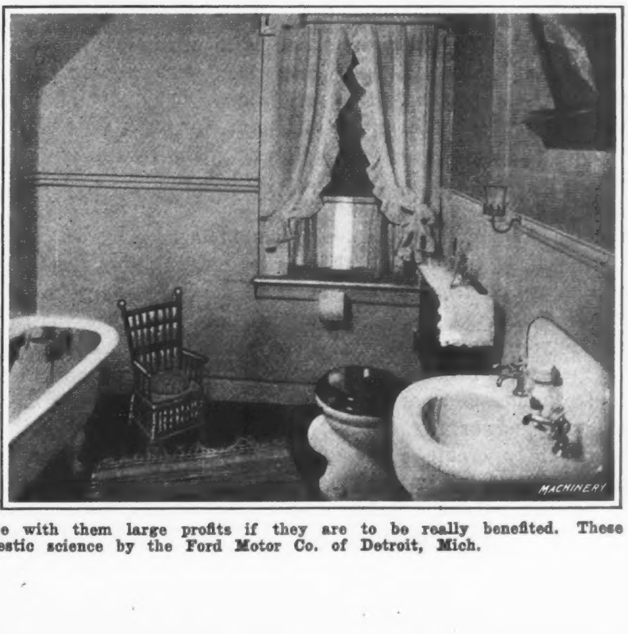
Let us take another case, and investigate the cause of falls. Suppose we find that some of these falls were caused by slipping on greasy man-hole covers, turntables, or industrial tracks. Such knowledge points out the necessity of using non-slip treads, or of covering metal floor plates with wood, and of keeping tracks clean and free from grease and oil. Suppose that some of the falls were caused by the defective soles of workmen's shoes. A campaign of education is necessary in order to persuade the men that shoes with loose soles are dangerous and should be discarded. Suppose we find that some of the falls occur on a certain stairway. Inspection of that stairway may show that the rise of one step is a quarter of an inch greater than that of the rest, which is a matter requiring the immediate attention of the carpenter.

Let us consider for a minute a third class of accidents—those due to projecting nails and splinters. These may be eliminated by substituting steel barrels and tote boxes for the wooden barrels and soap boxes often employed to hold parts, and by requiring all cleats, boards and sticks to be immediately removed from the floor, properly sorted and stored in designated places.

Enough examples have been given to show the possibilities arising out of a collection and classification of accident statistics. The more thoroughly statistics are collected and the more completely and logically they are classified, the greater will be the value of this kind of work. Nor should these statistics be confined to accidents requiring medical attention. "Near accidents" ought also to be reported even though no harm results. A man may slip on a stairway, pick himself up and go about his work without any injury whatever. Yet the circumstances which caused him to slip may cause a serious injury to someone else, and "near accidents" of this kind often deserve the same attention and study as accidents which cause severe injuries. Nor should attention be devoted exclusively to one's own shop. A study and classification of accidents reported in other shops is of great value in indicating possible danger points which might otherwise escape attention. The study of safety devices in use in other shops may in the same way suggest valuable safety devices for similar lines of work and obviate a number of accidents.

Some of the causes of industrial accidents are quite obvious and are readily determined by even a cursory study of accident statistics. Others, however, are difficult to determine because of their nature. Fatigue may be taken as an example of this type of causes. Fatigue is a frequent cause of accidents which occur late in the day and of those occurring in laborious work and in work conducted under hot or otherwise disagreeable conditions. Darkness is another cause of accidents which is sometimes difficult to fix upon. A machine may be in a fairly well lighted place, and yet at the approach of nightfall at certain seasons of the year may become a source of danger because of the lack of illumination. Here again the time of the accident may serve to show its cause. In studying accident statistics it is well to have before us a complete schedule of the causes of accidents and to consider which of these have anything to do with the matter.

In this connection it may be pointed out that not infrequently an accident will be due to a combination of causes, none of which acting singly would be sufficient to produce it. The abolition of one of these causes may prevent the recurrence of the accident, but, wherever possible, all of them should be abolished, since the remaining causes may in time produce other accidents. The causes and best methods of prevention of industrial accidents are worthy of the most thorough and scientific study.



Figs. 18 and 19. It is necessary to do more than pay men good wages or share with them large profits if they are to be really benefited. These pictures illustrate the results of instruction in hygiene and domestic science by the Ford Motor Co. of Detroit, Mich.

Fig. 20. View in the storeroom of the Ford Motor Co. Note the abundant light, the wide passageways and the careful manner in which the material is stacked. All this promotes safety.

Safety Education

A fact of great importance which has come to light through our scientific study of industrial accidents is that the safety of any plant is largely determined by the mental and physical habits of its workmen. Certain prevailing habits of mind will be found in every industrial plant. In one plant, for instance, the foremen and workmen will approach every job with the idea that it must be done in the easiest way. In another plant every job will be approached with the idea that it must be done in the most expeditious way. In a third plant the prevailing attitude of mind will be that the largest possible quantity of work must be gotten out. In such cases the question of safety is rarely considered when work is being planned or performed. It is only when danger becomes obvious that safety receives consideration. Effective safety work requires a thoroughgoing campaign of education.

One of the first steps in safety education is to establish in the minds of foremen and workmen the habit of making safety the first consideration when work is being planned or performed. After that come considerations of quality and quantity of output. At every step in the process of performing a new task the workman must be taught to ask himself, "Is that safe? Is there a danger spot anywhere?" Whenever there is a departure from the usual procedure or conditions of work, the same questions must be asked. Not only is it difficult oftentimes to get men to consider these questions, but not infrequently they feel that it savors of cowardice. It is therefore not only necessary to establish new habits of thought, but also to uproot the idea that courage and manliness require that they shall ignore considerations of safety. The more dangerous the occupation the more necessary it is to do this, for men so engaged are often foolhardy and delight in taking unnecessary risks in order to show their courage and skill in escaping the dangers of their occupation.

A second step in safety education is to break the workmen of dangerous habits while at work. Men will often be found performing their tasks in unsafe ways. They should have those dangerous methods pointed out to them and safer methods should be devised and followed. The result of such a practice is that dangerous habits which are the causes of accidents gradually disappear.

A third step in safety education is to instruct the men in the causes of accidents. This is a place where accident statistics are of great value. It is all very well to point out to a man that he is doing a dangerous thing, but when you can back up your statement with the further information that three men were injured last year while doing the same thing, and give names and particulars of the accidents, the lesson is much more powerfully impressed.

In order to create a more widespread interest in safety work as well as to get the largest possible volume of information on the subject, "safety committees" have been found useful. A safety committee consists of a number of men chosen from among the foremen and workmen in such a way that every department is represented. The safety committee is often elected by the workmen. It meets at specified intervals in order to study the causes of accidents, to make regulations for safety, and to create an interest in safety work. In order to bring the largest possible number of men into this committee and to give the whole body of employes a knowledge of the way in which safety work is carried on, and to inspire them with an enthusiasm for the safety movement, the members are changed at frequent intervals. By this means every workman, in course of time, is caused to study the condition of the plant with a view to making it more safe. The mere fact that for a month or two he has the problem of safety more or less on his mind and talks with other workmen about some of the things which he is considering spreads a knowledge of safety work and brings all the men to consider the problem in a serious manner. Even after such a man has left the safety committee, his interest continues and he has a new conception of his duty both to himself and to his fellow-workmen.

A great deal is being done in the general education of the workmen by means of placards, pamphlets and lectures, and by bringing to their minds the necessity of considering questions of safety. It is pointed out to them that "it is better to be safe than to be sorry," and that a moment's carelessness or the neglect of some prescribed plan may cause them much suffering and loss of time and wages. It is also pointed out that carelessness will make them a menace not only to themselves but also to their fellow-workmen, and that they owe it to every other man in the shop to so conduct their work as not to harm their fellow-workmen. It is pointed out to them that if they see any dangerous condition or practice which is likely to injure them or others, it is their duty immediately and forthwith to report it. They are impressed with the idea that the company and every fellow-workman owes them absolute safety, and that it is their right to demand it. With such a system of education an entirely new attitude of mind toward industrial dangers is created, and the cooperation of the workmen becomes a powerful factor in promoting safety work and eliminating danger spots.

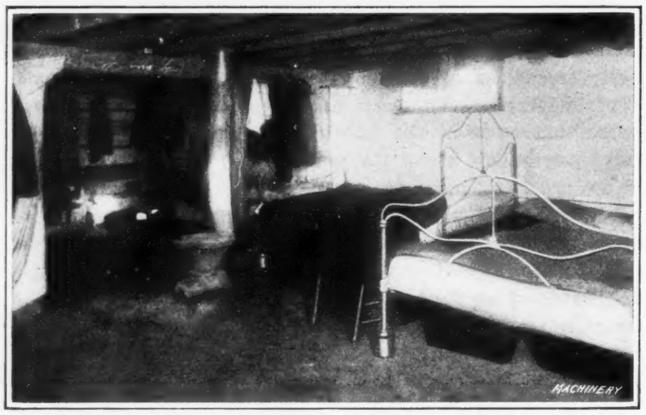


Fig. 21. When men receiving thirty-four cents an hour sleep in such quarters as these, it is evident that they need something besides high wages. This is a basement room and the bedsteads are set up on tomato cans because the floor is frequently ankle deep with water.

Improving Dangerous Machinery

There are a great many machines and kinds of work which are subject to special types of accidents. The punch press is a case in point. The punch press has in the past been the cause of the loss of a great many fingers. For years this loss was regarded as sad but inevitable. Any attempt to provide the punch press with safety devices was considered to be impracticable because it would reduce the speed and in-

crease the cost of the work. As soon as safety became the first consideration, however, the question of the punch press was taken up, and several solutions were offered for the problem of abolishing the danger.

The first solution of the problem was the suggestion of the workmen. It was that the work be put on a day-rate basis and that a small task be expected in order that the men should not feel hurried in their work. The workmen thought that if they took their time about it, they would perform their task in a perfectly safe manner. This suggestion was a failure for two reasons. The first one was that the production was so reduced as to make the cost of the work appear to be prohibitive. The second was that the work was not made noticeably safer. Because the work was done slower, the men's movements did not have that automatic quality which is one of the requirements of safety, and in consequence injuries were still frequent.

A second solution was to so arrange the press that *both* hands were employed in order to start it. This of course made the operation of the press slow, although it was perfectly safe since it was impossible to have any part of the hands under the punch while the press was moving. The loss in speed, however, was not as great as was anticipated, because as soon as the fear of injury was removed, the operators became more skillful and certain in their movements, and the mental fatigue occasioned by the sense of danger was no longer felt during the late morning and afternoon hours, as had previously been the case.

A third method of attacking the difficulty was to place a guard before the punch which had to be clear down before the punch could start. With the guard down, the hands were necessarily out of the way. This arrangement permits of faster work than does the method of using both hands to start the punch, although perhaps theoretically it is not quite so safe since a derangement of the guard may occur. A fourth method was to make the punch self-feeding, so that it is unnecessary to place the hand near the punch when it is in operation.

So far we have considered making the punch safe. There is, of course, the alternative of making the method of work safe. Instead of so arranging the punch that the workmen's hands are removed from danger before the punch starts, tweezers, sticks and so on may be employed to handle the work so that the workman does not put his hands in danger. Workmen soon become so skillful in using properly constructed tools of this kind that their efficiency is not materially less than when the fingers are used.

Woodworking machinery is a type of dangerous machinery in which the best results are obtained not so much by guarding the machinery as by teaching the workmen safe methods of work, and insisting that they be followed. Of course guards are important in woodworking machinery, but they are effective in eliminating only a fraction of the accidents. The jointer is a machine which causes more finger accidents probably than any other machine in the pattern shop. Practically all jointer accidents are caused by an improper use of the machine. I know of a number of such. One was caused by a loose sleeve which caught in the jointer knife, drawing the man's hand in. A second was caused because the man attempted to plane the flat side of a piece that was only four inches square. A third was caused by the operator stumbling in the pile of sticks and shavings in front of the machine. A careful study of the jointer and the cause of the various accidents which occur will show that when properly used, a jointer is a safe tool. The fence must be close to the working side so as to leave as little of the knives uncovered as possible. The knives must be sharp and in good order so that the force required to feed the piece will be slight. A guard which covers the knives and forces the work against the fence will eliminate many chances of accidents. Wood which contains many knots or nails is dangerous, especially when it is in short lengths or small sections. Many men get themselves in trouble by attempting to work up small pieces in the jointer. When it is necessary to handle such pieces special methods should be devised for handling them safely. Flat wood may be handled more safely if a tool which looks something like a plane handle, is employed in order to push it through. Thin square sticks may be fitted into a recess in a larger piece, so as to be handled safely. Jointer accidents are entirely unnecessary, and by using proper precautions in performing the work, always doing it in the safest way and never taking any of the risky methods, they may be eliminated.

Not only should we strive to eliminate accidents, but a good deal may be done to make accidents less serious if they do occur. The old-fashioned square jointer head which permitted the whole of a man's hand to be caught between the knife and the table would produce a much more serious accident than the modern round head which gives very little room for the fingers to be caught. A week's careful study of the methods of work which may be safely employed on a jointer, of the proper form of guards, and type of cutting head, and the provision of special appliances for making the dangerous work safe, and of a convenient cabinet or rack in which these appliances may be kept for use, will eliminate a great many painful and serious accidents. Similarly, any tool or machine which is likely to cause an accident, will repay careful study, and this study, if it is to be really effective, must take up not only the question of guards and safety devices, but also the matter of methods of use.

Equally as important as the elimination of industrial accidents is the proper treatment of those accidents which occur. Many injuries which are originally very slight, may, because of lack of prompt attention, become serious or even fatal. Not infrequently a small cut or scratch may develop a case of blood poison. Injuries of the eye may give a great deal of trouble if they do not receive proper treatment. Strains and sprains recover much more quickly if they have prompt treatment. Consequently a "first-aid" room of some kind where men can receive intelligent treatment for slight injuries ought to be a part of every industrial plant. The first-aid room may be under the supervision of any intelligent person who has been thoroughly trained in the emergency treatment of minor injuries, but if the size of the plant warrants, it should be under the supervision of a physician, and equipped for emergency operations. Many large industrial plants have a thoroughly equipped operating room with the necessary surgical tools and apparatus, and hospital supplies. It should be insisted that any eye injury,

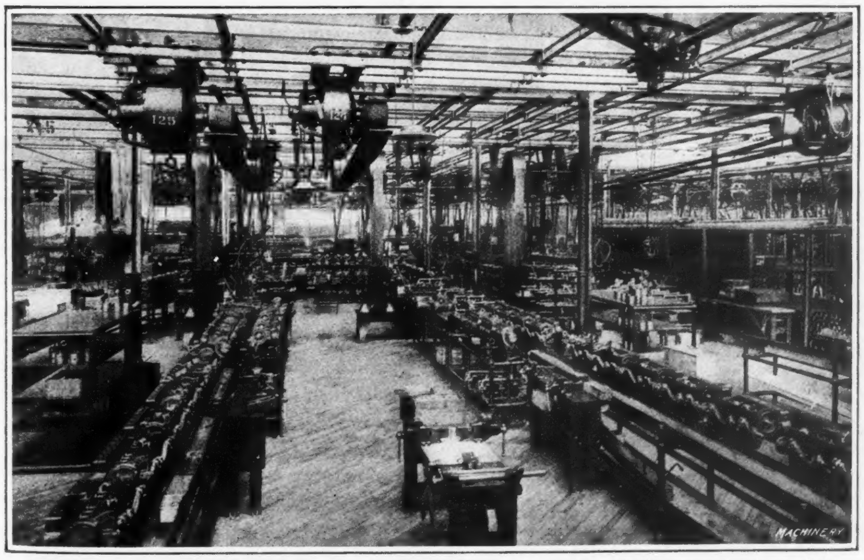


Fig. 22. An assembly department in the Ford Motor Co.'s works. Notice the abundant light and the great amount of space which gives the men plenty of room to work in.

any wound sufficient to cause a flow of blood, and any strain or sprain should be immediately reported to the one in charge of the first-aid work for treatment. Prompt measures in this regard will often save a great deal of time and suffering, as well as expense.

Community Betterment

So far the welfare activities which we have considered are carried on within the plant. They have to do with the workman while engaged in his work. Their object is to increase his welfare and efficiency as an employe and to properly remunerate him for what he does. Here the moral and social responsibility of the employer, as an employer, ceases. There are other forms of welfare activities in which he can engage for the benefit of his employes, but he does it not as an employer but as a philanthropist.

In undertaking work in community betterment the employer finds himself in a field already occupied by other social agencies, some of which are commercial while others are purely philanthropic. For instance, in promoting a benefit association which would give his workmen sick insurance, he is competing with many insurance companies organized for this very purpose. In attempting to promote the community welfare and to raise the community standard of intelligence and physical well-being, he engages in the same work as that of the Y. M. C. A., the social settlement, or even the public schools. In furnishing housing for his employes, he assumes the place of the landlord. In spite of this there may be ample justification for such activities. The employer is certainly entitled to do anything which will benefit the community, and to become a leader in the work of community betterment whenever his ideals and ability warrant his assuming such leadership. At the same time we must clearly recognize that this phase of welfare work is on a different basis from that which is done within the industry itself. In engaging in it the employer must cease to be the boss and learn to be the leader. He must learn not to rule but to cooperate. His activities must recommend themselves to the good sense of the community because of their benefits and not because of any particular relation which exists between the employer and the other members of the community.

Some kinds of work are difficult to classify and it is not easy to say whether the employer conducts them as a matter of community betterment or simply to increase the welfare and efficiency of his working force. They may be begun with the latter object in view and yet they are always tending to spread out until they affect the welfare of the whole community.

Education

Education is an example of this kind of work. It is not essential to the conduct of the industry that the employer should *educate* his workmen. He may allow them to pick up their own education in the course of their employment, as is frequently done even where the men are supposed to serve an apprenticeship. There are many shops in this country in which absolutely no attempt is made to instruct apprentices. A boy enters a shop and is given simple and easy jobs to do until his own observation and native ability make him capable of attempting something harder. In the course of time if he is naturally bright and ambitious, he may manage to acquire a smattering of the trade at which he is supposed to be apprenticed.

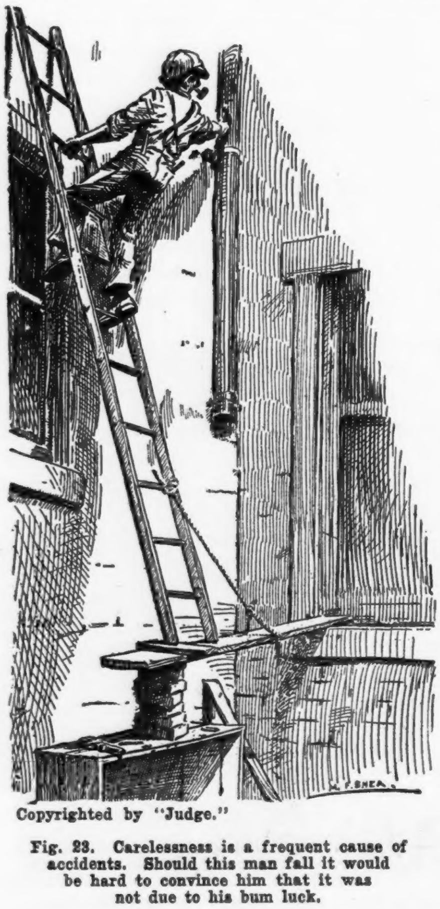
A majority of the men engaged in many trades have never been apprenticed. The machine industry is a case in point. Because of the objection on the part of labor unions to the training of an adequate number of apprentices, and because of the fact that many young men do not care to apprentice themselves, it has for many years been necessary to operate machine tools with the help of unskilled laborers who gradually familiarize themselves with the operation of some particular class of work or kind of machine tool. Such men, if intelligent, are soon able to obtain employment at the particular line of work which they have picked up, so that we no longer have machinists, but have instead lathe hands, planer hands, shaper hands and so on. This matter has gone so far that we often hear a workman referred to as a Smith & Jones lathe hand, or a Byron & Robinson milling machine hand, according to the make of tool which he has been trained to operate.

This system is unsatisfactory both from the standpoint of the man and from that of the employer. In the first place it limits the man's opportunity for employment since the character of the work which he can do is limited. In the next place the employer has much greater difficulty in filling a vacancy for the reason that a large proportion of intelligent and competent applicants will not be skilled on the particular machine which he desires them to use. The result is to greatly increase the number of idle operators, to make it more difficult for men to secure positions, to make it more difficult for the employer to secure help, and to reduce wages. The obvious remedy for this state of affairs is for the employer to provide or cooperate with a system of industrial education which will produce men competent to engage in a much larger field of work. Under present-day conditions it is possible to improve greatly upon even the best of the old-fashioned apprentice systems.

In the first place, because of our improved school system, young men having a better preliminary education may be secured for apprentices. They have a knowledge of mathematics and science which will be of great value to them. Many of them have done manual training work, and thereby gained a certain grasp of elementary mechanical problems and an ability to read and to make drawings, which is of great value. Not only can the modern shop secure better material for its apprentices, but it is able to give them better instruction. We have learned a great deal about education in the past few years. We have learned how to teach to the best advantage, and how to give the maximum of instruction and development in the time that we have at our disposal.

One of the best apprenticeship courses in this country is that conducted by the Brown & Sharpe Mfg. Co. of Providence. A toolmaker serves an apprenticeship term of four years, during which time he is given a thorough course of instruction in every branch of machine work. He does not go in a haphazard manner from one class of work to another, but the amount of time spent on the different classes of work is carefully proportioned to the importance of the work and to its difficulty. A portion of this time is spent each week in the company's schoolroom where he studies mathematics, drawing and other theoretical subjects. When he has finished his course, he will have received excellent and thorough instruction in a variety of subjects of which the old-fashioned apprentice never even so much as dreamed.

In giving such a course of training as this, the Brown & Sharpe Mfg. Co. is, of course, promoting its own interests. It secures in this way a corps of



Copyrighted by "Judge."

Fig. 23. Carelessness is a frequent cause of accidents. Should this man fall it would be hard to convince him that it was not due to his bum luck.

workmen of the highest class, which insures that its products shall be efficiently and carefully made. On the other hand, it must always be remembered that the training is of more benefit to the young men than to the company. It enables them to make high wages, and to secure employment at practically all times. It has put them in a class by themselves because of the knowledge and ability which they have gained. In training them in this way the company has been doing the very finest kind of welfare work. It has done more for these men than any system of profit-sharing or any other form of welfare activity could do.

If such a system of training is to be worth while, it must be well done. There is no branch of endeavor in which it is more difficult to distinguish between the good and bad than in education. Any system of training must be in the hands of a competent teacher who understands the true objects and proper methods of educational work, and who knows how to train and develop young men, or it will be largely a waste of time. To place the burden on the shoulders of the already overworked foreman is folly. To pay low wages while the boys themselves, through their own efforts and observation, pick up a smattering of the trade, and then to call such a scheme an apprenticeship course, is dishonest. Because such boys are not trained or instructed, they never grow to be worth very much unless they have unusual ability to start with. Their work will be small in quantity and poor in quality, and they will find it difficult to earn even the small wages which they receive. A poor apprenticeship system may be properly designated by the term "illfare work," and is really no better than no system at all.

The educational work which an employer does, need not necessarily be confined to the training of apprentices nor to instruction in shop processes and methods. It is often worth while to conduct educational classes for the benefit of employes who are already advanced beyond the apprenticeship stage, thus greatly increasing their efficiency and value. A draftsman, for instance, may with advantage learn a great deal about foundry and machine work. A blacksmith may with advantage learn something about the metallurgy of steel and the theory of heat-treatment and hardening. Machine tool operatives will find it a great advantage to learn drafting, shop arithmetic and geometry. By giving these men opportunity to learn other lines, their intelligence is quickened, they become better employes, and a larger sphere of usefulness is opened to them.

Many employers are beginning to extend their educational work beyond the limits of industrial training. In those industries in which a large number of recent immigrants are employed, education in English is of benefit to the men and to the company, and is undertaken in many plants. This work is usually done during the evening hours. The company furnishes the necessary rooms for the work and often pays the teachers.

On account of the fact that the efficiency of the employe depends a great deal upon his health, many companies believe that it is to their interest to give instruction of some kind in matters of sanitation and hygiene. This is attempted usually by means of lectures and pamphlets, and by personal advice from the company's physician to employes suffering from indisposition. In this connection it must be realized that a very considerable portion of our working population are of foreign birth who have had no opportunity to attend American schools and that many of those of native birth have had their education curtailed for various reasons. In giving such advice and instruction, the company is merely supplementing our public education system, and giving to their employes something which they should have had but which circumstances forced them to miss.

In this connection it may be noted that when some men suddenly find themselves with a considerable increase in salary, they do not know how to spend it. A few of them continue on the same scale of living and save their increase. Many of them spend their increase foolishly, and sometimes in ways that are harmful to them. It has been the experience of most employers that when the wages of their unskilled laborers are raised gradually through a period of years, the men learn to spend the increase wisely, but that when wages are raised suddenly the increase is often expended foolishly unless special pains are taken to teach them what to do with it. To expend wisely money earned often requires more good judgment than is needed to earn it.

Many employers, therefore, are cooperating with social workers, educational clubs and so on for the purpose of educating the community in matters of personal and community welfare. Many workmen need to learn what we mean by the American standard of living. They need to learn the advantage of keeping their children in school as long as possible. They need to learn American standards of morality. Their wives and daughters need to learn cooking and dressmaking. In doing this sort of work, the employer needs to use great tact. He must treat his workmen not as persons dependent upon him for their livelihood, but rather as fellow-citizens. As far as possible, the work should be carried on through agencies which are not part of the corporation. The churches, the social settlements, the fraternal organizations of the community, and the employes' cooperative association (if there is one) may all do a part in this work, stimulated thereto, and financially assisted by the wise and thoughtful employer.

Cooperation in Little Things

There are many ways in which an employer may cooperate with his employes in order to save them loss of time and waste of effort. Such cooperation does not involve much expense to the employer, but the aggregate saving of time, effort and money may be of great importance to the employes. I have in mind a firm whose employes are organized in a cooperative and benefit association. The firm allows the association the privilege of having a store for the sale of tobacco, candy, magazines, and a variety of other articles, on the company's premises. There are two advantages in this: In the first place, it saves the employes' time by making it unnecessary for them to go out of their way to purchase such articles at other stores, and the cooperative association reaps the profits resulting from the sales. This cooperative association also maintains a push-cart service throughout the works. From these push-carts employes may at any time purchase tobacco, candy, gum, sandwiches and milk. This firm believes that such service is beneficial to the men and of advantage to the company. Of course this is a matter open to question. Many will question the benefit of such purchases during working hours, and many others will suggest that such service will have an adverse effect upon the efficiency of the men and on the quality of the work done. These questions can be settled only by observation and experience.

There are numerous errands which every man finds himself compelled to do one time or another, and which in the aggregate take a considerable amount of time and carfare. A great saving in these items may be effected by intelligent effort on the part of an employer. For those employes who are interested in books, some firms maintain a branch of the public library. The library collects and delivers books at the plant, receiving requests for specified books or classes of books, and filling them as far as possible at the next delivery. In this way, many trips to the library are saved.

Another way in which an employe may be served in such matters is by making arrangements to help him pay his bills. An employe having a bill which he wishes to pay may make out an order on a printed form to which is attached a copy of the bill. The order directs the firm to pay this bill and charge the same to his wage account. The firm then notifies the merchants that it is prepared to pay certain bills owing them by their employes, and the merchants' collectors, upon receipting the several bills, receive a check for the total amount. The amounts of the individual bills are then deducted from the wage accounts of the several employes, the employes receiving the receipted bills in their pay envelopes on the next pay day. This scheme is satisfactory both to the merchant and to the employe. The merchant makes his collections with a minimum of trouble, and the employe is not obliged to visit the merchant in order to settle his account.

Fig. 24. View in the men's dining-room of the Pierce-Arrow Motor Car Co.'s plant. This room seats 800 and each day an appetizing and nourishing meal is served for fifteen cents. This dining-room is very popular because the men get good food of the kind that they like.

In one case in which this scheme is used, practically all the employes avail themselves of the opportunity in paying their gas, electric light and telephone bills.

Some firms make the services of their purchasing department available for their employes when they desire it, and the employes are thereby enabled to make a considerable saving in certain classes of purchases. This is especially the case with hardware, stoves, coal, building material and furniture. Employes of this concern have saved hundreds of dollars when building homes through the services of the purchasing department. A further extension of this idea is the establishment of a cooperative purchasing association among the employes. The employes buy their supplies in quantities at wholesale prices, and utilize the transportation facilities of the company in order to distribute them. A considerable saving has been made in this way, the company donating storage facilities, the use of a motor truck delivery, and the services of the purchasing department.

Mutual Benefit Associations

Mutual benefit associations (or cooperative associations, as they are sometimes called) were originally established to care for sick and injured workmen. Usually they were instituted at the initiative of the employer. Not infrequently the cause of his interest was a desire to relieve his own pocket of the demands which charity was continually making upon it as a consequence of industrial accidents. At the time when mutual benefit associations first came into being, the burden of industrial accidents lay entirely upon the shoulders of the workmen, and because of the inferiority of the public health service of that day, serious illness was much more frequent than it is now. In consequence, the mutual benefit association was an organization which met a clearly defined need on the part of the employes, and its usefulness was great. With the growth of the workmen's compensation laws, however, the necessity for accident insurance has disappeared. Modern science is steadily reducing the amount of serious illness among our working population, and as a result the health insurance feature is less important than it was. It may also be pointed out that there are now many insurance companies who sell health and accident insurance at reasonable rates, and that a great many workmen are members of fraternal organizations having sick benefit features. However, the cost of the sick insurance provided by such mutual benefit associations is usually less than the cost of such insurance in commercial insurance companies or fraternal orders, and a great many men become members of mutual benefit associations who would not take advantage of the other forms of sick insurance. When wisely conducted, and especially when conducted in cooperation with a medical inspection and dispensary service, a mutual benefit association is still of great value.

The funds of mutual benefit associations are usually derived from the workmen. The employer sometimes contributes part of them, and in a good many cases fines levied for infractions of the rules are turned over to the mutual benefit association. Sometimes a share of the profits of the business is assigned to such an association. Sometimes the association has the use of a part of the company's property and often collects its funds through the pay master's office. Nevertheless, the fact remains that in most cases practically all the funds of the association are derived from the employes themselves, and to them belongs the credit of the work which it accomplishes.

The mutual benefit association need not, by any means, confine itself to sick insurance and death benefits. It may engage in any form of social activity which will benefit its members. It may become a very effective agent through which the employer can carry on much of his welfare work without arousing that antagonism and friction which sometimes appears when the employer attempts to become a leader in community welfare. The mutual benefit association has one very great advantage over any other agency which the employer can use for this purpose, because it is entirely democratic, and its efforts are not open to criticism from the employes. When such an organization is directed by a wise body of officers who have a realization of the needs of its

members and of the community, and have a vision of the kind of services which such an organization may give, an enormous amount of good may be done.

The nature of the work undertaken by such an organization and the benefits to be expected from it will vary according to the circumstances. A mutual benefit association of the employes of a small or medium sized plant located in a small town will have radically different opportunities and possibilities from one organized in a very large plant, especially if this plant is situated in the midst of a great city. However, there are many things which such an organization can do. It can, for instance, undertake the cooperative purchasing of family supplies, clothing and furniture, thereby saving its members many dollars. It can conduct a properly safeguarded savings and loan department, in which its members may deposit their savings, and from which they may receive loans in time of real need. It may conduct a building and loan association, accepting the savings of its members, and loaning money, upon proper security, for the construction of homes. It may conduct literary, social, and athletic clubs, musical organizations and so on. Under competent leaders it may organize the boys and girls of its members into companies of boy scouts and campfire girls. If its officers are wise and tactful, they can do much in influencing the younger members and in keeping them in the right paths. It may be so organized as to form an effective and satisfactory substitute for the labor union, serving as a connecting link between the employer and the employes, and presenting to the employer the wishes and needs of all classes of workmen. Finally it may enable the employer and his executives to come into personal contact with the workmen so that each may come to know the character, the ideals, and the wishes of the other, and incidentally, as one employer has put it, "Learn that the other fellow does not wear horns."

The employer may further the work of such an organization in many ways. In a large number of cases employers have contributed a large part or even the whole of the cost of construction of a club house for such an organization. Not infrequently a share of the profits of the business or an annual appropriation of stated amount is set aside for the work. Some employers have secured the services of social workers of experience and ability to supervise the work of the organization, and paid their salaries. In order that such an organization may be successful it is necessary that the workmen shall have leaders of ability among their number. There have been cases where employers have successfully provided for this need by hiring men whose nominal employment was connected with the work of the plant, but whose actual business it was to become leaders and directors in the work of the mutual benefit association. These men were chosen not because of their qualifications for the work which they nominally performed, but because of their ability as organizers and social workers.

The Housing Problem

Every large industry creates in any community in which it settles a housing problem of considerable magnitude. Many such an industry has bolstered up a dying community, has given value to its tumbledown dwellings, has greatly increased the rent of its stores, and has from the standpoint of the real estate dealers, very greatly increased the community's prosperity. The thoughtful employer, however, does not consider this real estate boom an unmixed blessing. He knows that it is his unskilled laborers who give value to the tumbledown tenements, and his skilled workmen seeking to build homes, who boost the price of vacant lots. He knows that all of this prosperity comes out of the pockets of his workingmen, and it is not at all surprising if he attacks the problem of providing houses for his employes at a reasonable rent.

One of the most successful attempts in this line is that of the Ludlow Mfg. Associates, of Ludlow, Mass. They are manufacturers of jute goods, one of the coarsest and simplest forms of textile work, and many of their employes are immi-

Fig. 25. View in the machine department of the Pierce-Arrow Motor Car Co. Note the excellent light, the abundance of room about the machines and the neat and orderly appearance of the shop and the system of ventilation.

grants, who make the jute mills a stepping stone to better things in the textile world. This firm located at Ludlow because of the water power there available. There being no place where their employes could be properly housed, they were obliged to begin the construction of dwellings as soon as they began the construction of the factory buildings. These dwellings consist for the most part of single or double tenements, of from five to eight rooms each. They are well built houses, kept in neat repair, nicely finished and decorated, and the company charges a rental of about six per cent of the cost of construction of the house. After allowing for taxes, insurance, depreciation and repairs, and the value of the land, the net rate realized on the investment is less than one per cent.

The dwellings provided by the company for their help, whose individual earnings range from six to eighteen dollars per week, and whose family earnings will probably average between eighty and one hundred dollars per month, are very greatly superior to the dwellings usually provided for this class of operatives. The rents range from $1.85 per week for a six-room house equipped with electric lights and plumbing, to $2.35 per week for an eight-room house with electric lights, furnace, bath and plumbing equipment. In most communities it would be practically impossible for labor of this class to afford to live in neat and sanitary dwellings, with ample grounds. In adjoining communities, such labor is obliged to find housing in huge tenements, often in bad repair, always with insufficient light and air, and usually at much higher rental than this.

This textile mill, by its liberal and enlightening policy in regard to housing, has secured for its help such favorable home conditions, that the work has resulted in a distinct profit to the mills. The fact that the houses are within a few minutes walk of the mills increases very materially the employes' leisure time, without the necessity of decreasing their working time.

The fact that the mill buildings are situated in pleasant surroundings and are convenient of access, promotes, in no small degree, the happiness and contentment of the employes. The fact that the houses have proper sanitary facilities, are kept in good repair, and have ample yard space, promotes good health and efficiency. Anyone comparing these houses with the crowded, dirty, sunless, ill-aired, and noisy tenements, which are the usual habitation of many American textile operatives, will understand why the death rate from tuberculosis among the Ludlow operatives is below normal, while among other textile operatives it is twice the normal rate.

The company began this system of housing as a matter of necessity. While they unquestionably feel that from a financial standpoint, they would be glad to withdraw from the work and invest their capital in more productive ways, it is also true that they are indirectly receiving a very considerable return from their investment, and their employes are profiting to a still greater degree. The company is apparently a generous landlord, and opportunities to rent their houses are eagerly sought by the few employes who are obliged to rent elsewhere because of the lack of a sufficient number of company houses. Of course it would be possible for the company to charge much higher rent for these dwellings, and to secure a reasonable return from its investment. If it did so, however, many of the employes would be obliged to seek cheaper (and less satisfactory) quarters elsewhere, and it would create in the minds of the men the idea that the company was trying to exploit them by charging exorbitant rentals. So long as the rentals are obviously low, and repairs are made promptly and willingly, the company receives the benefit of a large measure of good-will, which would disappear the instant it attempted to make a paying investment out of this portion of its capital.

Another New England firm, with an entirely different class of employes, who is also attempting to do something in the housing problem, is the Draper Co. of Hopedale, Mass. On account of the rapid growth of this company, which manufactures all kinds of textile machinery and which employs two or three thousand machinists, molders and other skilled workers, it became necessary to provide housing for its employes. The Draper Co. has built several hundred desirable tenement houses with first-class equipment in every respect, with handsome exteriors, well kept lawns and very nicely finished and decorated inside. While the rent charged for these is low, it is still high enough to bring a rate of three or four per cent upon the investment, after making deductions for necessary repairs, depreciation, insurance and so on. The housekeepers are quite enthusiastic in the praise of the company as a good landlord, remarking on the excellent repair in which the houses are kept and the very satisfactory conditions that the company maintains. There are not sufficient houses for all the Draper Co.'s employes, but I understand that there is never any lack of applicants for any of the houses that may become vacant.

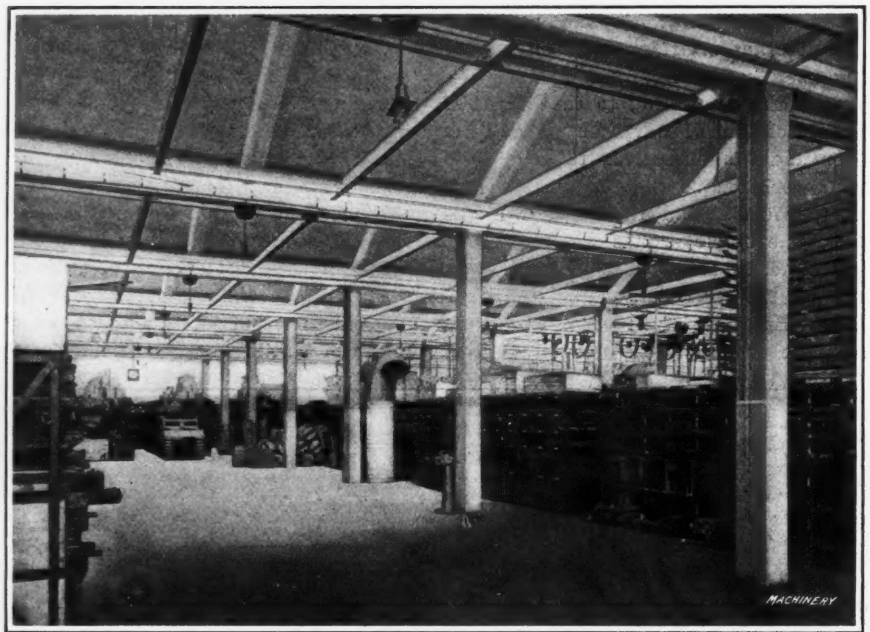


Fig. 26. A corner in the storehouse of the Pierce-Arrow Motor Car Co. While the unusual floor space and the excellent equipment is costly, they save money by keeping the stock active and facilitate the work of the storekeeper.

One cannot avoid the impression that of these two companies the Ludlow people are doing a much more necessary work. The employes of the Draper Co. are mostly skilled workmen who command good wages, and who would be able to secure for themselves proper and sanitary housing. It is true that it would be difficult for them to find quite as pleasant conditions as they enjoy in Hopedale, where the brains and resources of a great manufacturing organization have been employed in building up a beautiful industrial village, but they unquestionably would secure very satisfactory conditions on their own initiative.

The employes of the Ludlow Co., however, would find themselves in a very different position without the assistance of the company. They have not the initiative or the ability to secure for themselves conditions anywhere approaching those which their employer secures for them. The Ludlow Mfg. Associates are doing a real welfare work which has a remarkable influence upon the health and general well-being of hundreds of families. Unquestionably this is a form of paternalism, but we must remember that first, the company was compelled to engage in this form of welfare work, and second, that the good which results is ample justification for this particular example of paternalism.

There is an old and very true proverb to the effect that "all is not gold that glitters." Many companies have been and still are providing housing for their employes who are

not engaged in welfare work. In many cases the housing is not what it ought to be. In many cases, the company creates a privately owned village, in which employes are deprived of the right of self government, and the company maintains complete control, not only of the houses, but of the streets and public places. Not infrequently the rents charged are high, when the nature of the accommodations is considered, and it is often truly alleged that the wages paid in such communities are so low, that cheap housing is a totally inadequate compensation. Before any form of industrial work can be truthfully classed as welfare work, it must be apparent that it is intended to and actually does benefit the workmen.

Workmen's Pensions

The problem of caring for those who are dependent because of superannuation or illness is a social and not an industrial problem. In those countries which have made the greatest advance in providing for the welfare of their citizens, old-age pensions, as well as sick insurance and unemployment insurance, are provided by the state. Our several states, however, have not considered the question of caring for those who are too old to work efficiently, and accordingly, old-age pensions are a feature of the welfare work of some corporations. One of the companies which has adopted this plan has done so because of the fact that failing activity, and especially failing eyesight, make employment with them impossible long before their employes would become superannuated in other industries. This corporation recognizes the fact that these men have given the best years of their life to the service of the company, and that while they are not too old to earn a living in other lines of work, they are too old to learn a trade or to begin a new kind of industrial life. Therefore, they consider that their employes are entitled to some compensation for the disadvantage which their employment has now forced upon them. Another reason why many firms have instituted pension systems is the fact that such systems induce the better class of employes to remain in the service of the company, particularly if they have already served them for a long time.

An efficient employe of good character, who is thoroughly familiar with his work, is a very valuable part of the intangible assets of any firm. For such an employe to leave his employment is a serious loss. Anything which will induce him to remain will be of advantage to the company employing him. The prospect of a pension secured at a given age by a required number of years of service is a very strong inducement for such a man to remain with the firm. It is not an inducement to a thoughtless employe who is not well trained, and who feels that he may lose his place because of his lack of ability. Such a system, therefore, acts as a sieve, retaining the best men, and permitting the others to depart. A pension system is in effect a form of profit-sharing in which the payment of the profits is deferred, the payment being made in the manner which will bring the greatest benefit to the employer, and the money going to the employes who have the greatest need of it.

There is considerable objection to a pension system in some quarters on the ground that it is "un-American," and "pauperizes" the workmen. It is argued that our American social and industrial system requires that good wages shall be paid to all employes, and that the "American plan" requires the workmen to save for themselves a competence for old age. In theory this is an excellent system. Every man saves part of his wages, and puts his savings in the savings bank. These savings form part of the community capital, making possible new industries, adding to the productive power of the community, increasing prosperity, and raising wages. When old age overtakes the workman, the savings are gradually withdrawn to support him in his declining years.

Like many other systems, however, the "American plan" is good only when it works. If the employe, because of lack of thrift (which in many cases is a doubtful fault) or misfortune or illness, or because he spends his surplus earnings in educating his children, or in providing for his family the opportunity for a more abundant and happier life, finds himself in his declining years without any savings, the scheme is unsuccessful, no matter how excellent it may be on paper.

A second practical objection to the "American plan" lies in the fact that it does not meet the basic requirement of any satisfactory pension system, which is that the cost shall be graduated in accordance with the pensioner's ability to pay and the pension shall be proportional to his needs. The employe who saves a satisfactory competence may be accidentally killed at the age of fifty-five, leaving no dependents. Another employe who is obliged to support a large family may spend all his savings in time of illness which renders him unfit for further active service. The "American plan" is unquestionably unsatisfactory.

We must therefore expect that the idea of pensions, as a reward for long service, will grow in the industrial world until our states are sufficiently advanced in applied sociology to provide such pensions out of the public funds.

A Remarkable Experiment in Industrial Democracy

The purposes which lie behind welfare work have been variously described by different employers. Some employers say that they are engaged in this work for the purpose of giving the employe a square deal. Some say that they are under moral obligation to do everything possible to promote the welfare of their employes. Others state that their object is to bring about a spirit of mutual understanding and cooperation between the workmen and themselves. Many employers in discussing their work lay stress on the idea that it must not be considered as a form of charity. They are at great pains to avoid the supposed evils of paternalism, and attempt to make the work as spontaneous and democratic as possible. It will be well worth while for anyone interested in these problems, to consider the very remarkable work carried on by the Filene Cooperative Association (usually known to its members as the F. C. A.) in the department store of the William Filene's Sons Co. in Boston. While this work is carried on among a class of employes and in a kind of business totally different from the mechanical industries, its success has been so great, its methods have been so unique, and the powers and duties of the F. C. A. are so unusual as to merit most careful attention.

There are three features which distinguish this corporation from any other mercantile or industrial corporation with which I am acquainted. In the first place, the employes have a voice in the conduct of the business. In the second place, the employes have complete control of all of the conditions of employment, including wages, hours of labor, rules and discipline. In the third place, the employes, through their own organization, carry on a very elaborate and successful system of welfare work. The policy of this corporation is so revolutionary in these respects that it at once challenges our attention.

The William Filene's Sons Co. is organized for the purpose of conducting the department store established by William Filene about the year 1888. It is capitalized at $400,000 and occupies an immense building in the shopping center of Boston. This corporation is governed by a board of eleven directors, *four of which are elected by the employes.* The great majority of these two thousand young men and women own no stock in the corporation, but are nevertheless, represented in the board of directors in this unusual manner.

Every employe of this corporation, by virtue of his employment, is a member of the F. C. A. The organization requires no dues. For the purpose of administration the store is divided into twelve sections in a manner analogous to the political subdivisions of a state. Each year the F. C. A. elects a president, vice-president, secretary and treasurer, who serve without compensation. These officers, together with nineteen others who are elected by sections, form a council or executive board of twenty-three members. The council elects an executive secretary and staff who have charge of the entire system of welfare work carried on among the employes. The salaries of this secretary and his staff are paid by the corporation and not by the F. C. A.

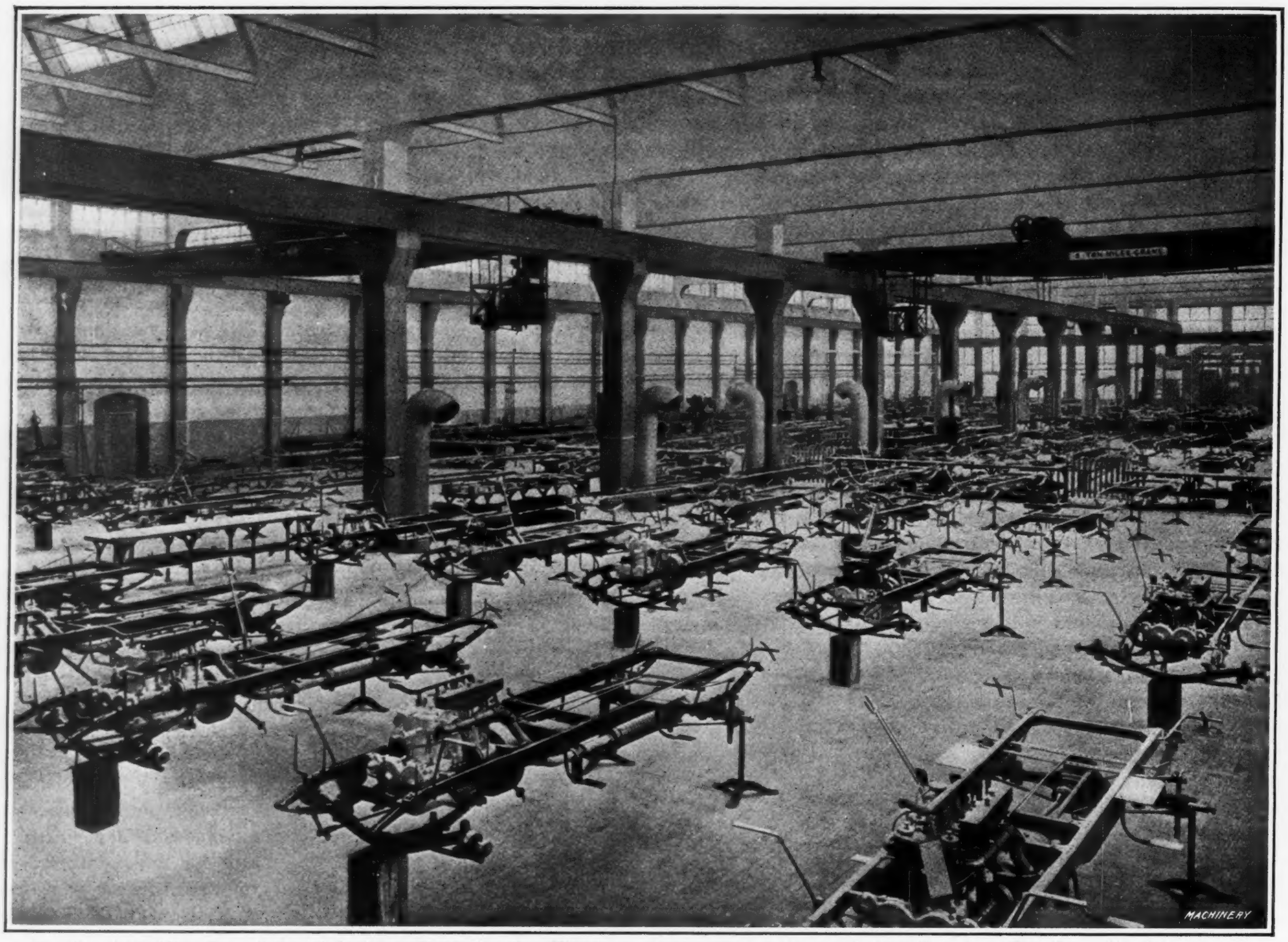


Fig. 27. Assembling floor of the Pierce-Arrow Motor Car Co. This is one of the most pleasant and attractive shops that the writer has ever seen.

Besides the F. C. A. council the members of the F. C. A. elect a number of committees whose duties are to supervise and control the various activities of the organization. The most important of these is the one known as the arbitration board. It consists of twelve members elected from different sections of the store and a chairman who is appointed by the president of the organization. It exercises powers which are in other organizations reserved entirely for the management. According to the constitution of the F. C. A. the arbitration board is established for the purpose of insuring justice in the administration of the work of the store. It has jurisdiction in all cases of difference arising between an employe and the management, or between two or more employes in matters of store interest, or in any case where the enforcement of the store rules appears to work a hardship or injustice. The questions most frequently brought before the arbitration board relate to discharges, changes in position, wages, transfers, loss of stock, differences between employes and so on. The decisions of the board are final for all cases arising within its jurisdiction. By a two-thirds vote it may reinstate an employe who has been discharged, or it may increase the pay of any employe or class of employes. In all other cases only a majority vote of the board is required to render a judgment. This arbitration board is in effect a court of last appeal in matters affecting wages or discipline. The justice of an employe's case is finally referred to the judgment of his fellow-employes.

It will be seen that through this arbitration board the employes of this store have complete control of all conditions of employment. While the firm itself is responsible for the management of the store and for its merchandising policy, the employes determine the wages, the conditions of employment, the hours of opening and closing, and the rules governing their conduct. It would appear to the average man, and especially to the average employer of labor, that this is a very dangerous power to place in the hands of the employes. Most of us, I fancy, would expect that the employes would take advantage of the fact in order that they might increase their wages and reduce their hours of labor beyond reason. Such has not been the experience of the William Filene's Sons Co. The employes have used their unusual powers with justice and fairness.

The following example will serve to make clear the attitude of the employes of this store when there appears to be a conflict of interests. The employes had at one time voted that the store should remain closed on July fifth when that day fell on Saturday, thus giving themselves a three days' holiday in certain years. In 1911 Bunker Hill Day, which was the 17th of June fell on Friday. Many employes felt that the store should be closed on Saturday, June 18, as it would when July 5th fell on Saturday. When the matter was put to a vote, however, the employes voted by an overwhelming majority to keep the store open. The reason for their action was as follows: During July the Saturday business following the holiday would be very light, and the store would lose but little business by being closed. During the month of June, the Saturday business is usually very brisk, and this is especially the case on the Saturday preceding Commencement week. The employes, therefore, voted to forego their holiday rather than to deprive the firm of the large volume of business which might be reasonably expected on that day.

There is no question but that the employes of the Filene store have secured for themselves admirable working conditions. The hours of work are very favorable to the employes. The store does not remain open on the evenings preceding Christmas. There is a minimum wage for girls of eight dollars per week. Apparently the employes treat themselves with as much generosity in such matters as is compatible with full justice to the firm for which they work.

The William Filene's Sons Co. believes that welfare work is most satisfactory and effective when it is carried on by the employes themselves. Accordingly the F. C. A., through its executive secretary and his staff and through a number of committees elected by the employes or appointed by the council, carries on a system of welfare work which is unsurpassed in variety and effectiveness by that of any similar

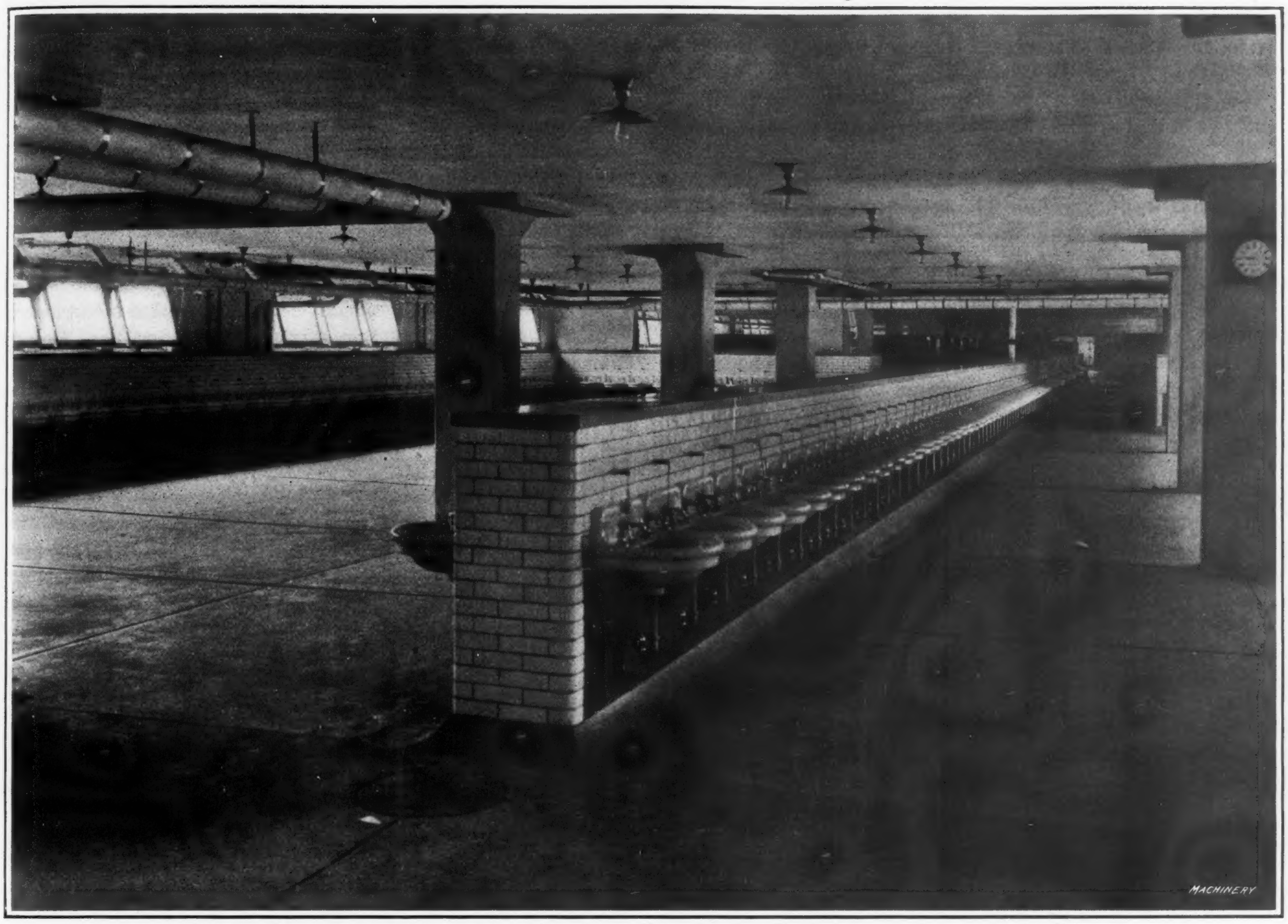


Fig. 28. View in the washroom of the Pierce-Arrow Motor Car Co. The lockers may be seen in the distance.

concern with which I am acquainted. There is a sick insurance and death benefit fund which is designed to take care of employes during periods of illness. A part of the store building is set aside for an employes' club house. A lunch room is maintained there for the benefit of the employes. The employes also have a cooperative purchasing association which enables them to reduce greatly the cost of many of their purchases by purchasing in quantities and under favorable conditions. A banking and loan association pays 5 per cent upon deposits and lends funds to those employes who might otherwise have to patronize the loan sharks. There is a medical department having nursing and dispensary service which cares for the health of the employes and the hygienic aspects of their employment. There are also educational classes, organizations such as campfire girls, men's, women's and girls' clubs, a dramatic club, an orchestra and various athletic organizations, and other minor activities.

It will be seen that the F. C. A. is an exceedingly active organization engaged in a great variety of social work. This is attested to by the fact that each year the organization receives and disburses somewhat more than $100,000. The William Filene's Sons Co. contributes to the support of the organization, but the greater part of the funds are furnished either by the employes themselves, or through their activities. Unquestionably the suggestions of the owners of the store are effective in initiating and controlling many of these activities, but the final control and direction of these activities is vested in a voluntary organization of the employes. That the scheme is successful and satisfactory in all its aspects is shown by the fact that the work continues to grow in volume and scope and that the company professes to be well satisfied with their very unusual experiment. The management is at present contemplating the installation of a system of profit-sharing in which, after paying reasonable dividends upon the capital stock, the surplus profits are to be divided equally between the management and the employes.

It is impossible to escape the conclusion that this industrial experiment of the Filene company is profoundly significant, and furnishes a possible solution for many of the industrial problems of the present day. It is impossible, for instance, to conceive of friction arising between the employes and the management when the conditions of employment are under the control of the former. There is no need for collective bargaining, nor for any kind of labor agitation. The fact that the employes are represented on the board of directors of the company gives them an insight into the workings of the corporation, and an understanding of its needs and problems. The system of profit-sharing makes clear the possible limits to wages, and impresses upon each employe the truth that wages must be paid out of earnings and not out of capital.

At the same time it must be recognized that before working people in general may be entrusted with the powers and privileges enjoyed by the employes of the William Filene's Sons Co., a preliminary period of education is necessary, and that if such a system is to be successfully introduced, it must be introduced gradually and not suddenly. To bring the economic errors and the present-day attitude of mind prevalent among working people, to the solving of such problems as confront the F. C. A., would result in the speedy ruin of the business.

Why Do Employers Engage in Welfare Work?

Employers are led to engage in welfare work either because they think it advances their interests or because they feel a moral obligation to do so. Not infrequently self-interest and conscience coincide, and many men who engage in such work because their conscience bids them do so, lay stress upon the advantages which they reap from it.

Self-interest is the ruling motive which has prompted many employers to engage in safety work. The operation of workmen's compensation laws has led them to look carefully into the danger spots around their plants, to guard their machines, and to educate their workmen to use better and safer methods of working. Self-interest leads many employers to take an interest in the physical welfare of their employes, for they realize that by keeping their operatives in good health, they are increasing their efficiency and so benefiting themselves. Many employers are fully persuaded that congenial conditions of employment, plenty of light, good ventilation, pure drink-

ing water, and perfect hygienic conditions result in increased dividends. These men engage in such work because they believe that it pays.

Self-interest leads other employers to engage in certain kinds of welfare work in order to attract to their service a higher class of employes than they could otherwise get. They believe that the efficient and dependable man is the man of superior skill, intelligence, and character, and that he appreciates the opportunities which come to him through certain kinds of welfare work. The "hobo machinist" who usually spends from two to six weeks upon a job before *wanderlust* compels him to seek employment elsewhere, is attracted by high wages rather than consideration for his welfare. Such a man is apt to give a "welfare plant" a wide berth, and the plant thereby escapes the expense of hiring and training him. By being careful of the welfare of his employes, and by making their employment pleasant and satisfactory, an employer can very greatly decrease the floating element on his pay roll and thereby increase the efficiency of his plant.

Still other employers engage in welfare work in order to gain the good-will of their employes. They believe that such work creates a feeling of mutual respect and confidence which minimizes that friction which is so destructive to efficiency. By their just considerations of the needs and wishes of their employes, they hope to avoid labor difficulties and the loss and trouble which spring from them.

Some men engage in welfare work because it is the style. Not that these men are actually striving to "keep up with the styles" in the manner that the women of fashion are popularly supposed to do, but they desire to do the right and proper thing, and without any true appreciation of the fundamental purposes of welfare work, they engage in it because other firms of note have already done so. Still other men go into welfare work for the sake of the advertising which they can get from it. It brings their product to the favorable attention of their customers and creates in the public mind a feeling of good-will toward them. Perhaps advertising is not the only motive which causes them to undertake such work, but it is often one of the motives, and such motives are frequently responsible for the accomplishment of a great deal of good.

Another class of employers engage in welfare work because their conscience lays upon them the duty of doing all that they can for the benefit of the men who help them to earn their profits. These men are glad that welfare work pays, and they are not at all averse to making it pay, or to securing any of the selfish advantages which may be realized from it. Self-interest, however, is not their first consideration, and they would engage in any line of welfare work which would benefit their men even though it could be shown that this work was conducted at a loss to them. Such men have always engaged in some form of welfare work, and their ideas and teachings regarding the duties and obligations of employers have been an important factor in building up better industrial conditions.

Unquestionably the principal reason for the present rapid growth of the welfare movement has been the development of what we may call the "social conscience" among employers. I wish to make a distinction between those employers already described who feel that they have a personal responsibility to each and every individual employe, and those employers who are beginning to feel that every industry exists primarily for social service, and only incidentally for the earning of dividends.

For many years our entire theory of economics was based upon the idea that every man was working continuously, consciously, intelligently, and determinedly for his own self-interest. According to the nineteenth century economist, the motto of humanity was "Every man for himself and the devil take the hindmost." We are, however, beginning to get a broader view of the purpose of industry. The best thought of the present day holds the view that industry exists for the welfare of society, and that the profit accruing to the owners is only an incident to its primary purpose. Let us take the case of a particular industry in order to illustrate this point. Formerly a railroad was regarded as an enterprise by which certain men could make a great deal of money. Nowadays it is regarded as an enterprise whose primary purpose is to serve the public, and whose incidental purpose is to make reasonable profits for its stockholders. We recognize that the making of profits is an essential part of the railroad's business, and that without them it cannot continue to serve the public, but we no longer believe that these profits are the one consideration which must settle every element of policy in the conduct of its business, and in its relations to its employes and its patrons.

It has been slow and uphill work to secure the establishment of this principle, but it is gradually gaining wide acceptance even among those who receive the profits. It is but a step from the public service corporation to the industrial corporation. Both are engaged in work essential to the public welfare. While there are many points of difference, these

Fig. 29. Store in the plant of the Pierce-Arrow Motor Car Co. conducted by the Mutual Benefit Association. This store has proved a great convenience to the employes.

differences are not so great as to produce separate codes of ethics. Hence we find a growing recognition of the truth that every industry exists primarily for the benefit of society, and that, in consequence, its owners are under obligation to do everything possible to promote the interests of their workers.

Cost of Welfare Work

Like every form of human activity the success of welfare work must be measured by the relation between the cost and the results obtained. From this standpoint welfare work is amply justified, for it is not usually very expensive. The National Cash Register Co. of Dayton is one of the leaders in this form of social activity. For years this concern has been noted for the lavish way in which the welfare work is carried on and for the great amount of good which it accomplishes. Notwithstanding this, the cost of the welfare work is a trifle less than six cents per employe per day. This includes the fixed charges on the plant devoted to welfare work, the cost of maintaining the beautiful park-like grounds, the cost of the medical and dispensary service, the value of the time given to the employes in which to avail themselves of some of the welfare privileges which the company offers, the cost of the company's educational work, and the cost of the work in community betterment.

The Attitude of Labor

Labor holds three different attitudes toward welfare work. The first of these is the attitude of working men in general toward such work. The second is the official attitude of labor unions toward such work as expressed in their official organs and the public utterances of their leaders. The third is the attitude of labor organizers and other salaried employes of the unions.

In general, workmen are highly appreciative of anything which obviously benefits them. Anything which makes for their bodily comfort or which makes their work safer or cleaner, or less laborious or disagreeable will have their unqualified approval. However, many forms of welfare work are not appreciated, either because the men do not see the necessity for such activities, or because they believe them to be an unnecessary outlay of money which might better be given to them in the form of increased wages. A good many workmen, for instance, do not appreciate proper shop sanitation, because they have no conception of the method of transmission of diseases, and they regard such efforts as a ridiculous waste of money. Other men hold similar views with regard to beautifying the grounds of an industrial plant. They imagine that an enormous sum of money is spent in this way, and that it could be made to give them a substantial increase in wages.

In considering the attitude of workmen toward welfare work there are four things which we must keep in mind. The first is the fact that workmen, like other men, resent anything which savors of paternalism, or which infringes in any way on their personal liberty. Any form of welfare work which appears to do this will receive unsparing condemnation. In like manner they resent any assumption of superiority, either in wisdom or in goodness, on the part of anyone else. This is especially true of workmen of American birth. For example, they have no objection to their employer's furnishing them with a hot dinner at a nominal cost. They do not consider such a thing to be charity but rather a part of their compensation. However, if the employer should attempt to feed them something which he thinks is good for them, but which they are not in the habit of eating, there will be trouble, because they think they know just as much about what is good for them as he does, and resent his assumption of superior wisdom.

The third matter which we must bear in mind is the hostile attitude of labor toward anything tending to promote their efficiency. Almost all working men believe that increased efficiency means lack of employment and lower wages. This is the principal although not the only reason for their attempts to secure an eight-hour day, to limit the number of apprentices, to abolish piece work, to prevent the introduction of scientific management, and to limit production. This economic error colors the working man's whole view of industrial life, and we must remember it when we are considering his attitude toward certain kinds of welfare work. Working men know that economists heap ridicule upon this idea and they have therefore learned to keep it under cover as much as possible. When this is their real objection to any proposal, they bring against it other and more plausible reasons. In such a case it is necessary to appreciate the important and hidden objection and to tactfully remove it by pointing out to them the substantial benefits which the proposed innovation will confer upon them.

Finally working men very often feel that they are not receiving a just share of the wealth which they help to produce. They are often justified in this belief, but they fail to recognize that the fault usually lies in our economic organization and is not due to greed on the part of their employer. When such men see great sums of money expended for welfare work, they often feel resentful, believing that the money should come directly to them in the form of increased wages. The fact of the case is that the possible increase in wages would be insignificant, and the probable reduction in efficiency would soon compel a reduction in wages.

Most of the employers who are engaged in welfare work are very sympathetic with the just aspirations of labor in general. The very fact that they are engaged in systematic efforts to improve the conditions of their employes argues that they are more likely to be just in their dealings with them than are those employers who do not take such an interest. It will usually be found that in those plants where welfare work is attempted, the attitude of the workmen toward their employers is very friendly, not so much because of the welfare work done but because they feel that they are receiving just and generous treatment. Their attitude toward the welfare work introduced by such employers is apt to be sympathetic and friendly, whereas the attitude might under other circumstances be one of suspicion and distrust.

The Union Attitude

The avowed purpose of the labor union is to increase wages, to secure shorter hours of labor, and to secure more favorable conditions of employment. This latter phrase denotes many of the things which are being introduced by employers in their welfare work. The official union attitude with respect to such matters as safety work, lavatory and locker facilities, and many similar things, is that the worker is justly entitled to them, that the union was organized for the purpose of securing them, that it has persistently fought for them, and that, in general, employers are merely performing their manifest duty in making such provision.

The attitude of the rank and file of the union, however, is the same as that of other workmen. They are very glad to have certain things done for them and they do not feel "pauperized" when it is done. A union workman is no different from any other workman and he is just as keenly appreciative of the advantages gained by a thorough and sympathetic study of his needs as is anyone else.

When employers attempt to do anything in the line of welfare work beyond the officially expressed wishes of the union, the official attitude of the union will be one of gratitude or objection, according to the nature and effect of the work attempted. There are several points which must be borne in mind in connection with the official union attitude. The first of these is that a labor union is the most dogmatic organization on the face of the earth. As a combined result of logic and experience (the logic oftentimes bad) labor unions have arrived at certain conclusions in regard to what is beneficial and what is harmful to their membership. In the main their conclusions are correct. They may have found that the results of certain activities were usually bad, and accordingly unsparingly condemn all similar lines of work, irrespective of the motives of the employer or of the effects of such work on the well-being of their membership. Their excessive dogmatism causes them to condemn some forms of welfare work which are not only entirely justifiable but highly praiseworthy.

A case in point is the union attitude toward the housing problem. Unquestionably certain companies have exploited their help in providing dwellings for them. The union attitude is therefore opposed to any provision of housing even by the most enlightened and sympathetic of employers, and makes no distinction between housing provided for the purpose of exploitation or to secure control of the activities of the workmen, and housing provided for the purpose of securing the workmen's best welfare. Similarly, the unions are opposed to the provision of dormitories or boarding houses or of any similar plans on the part of employers, although this is often one of the finest types of welfare work.

In like manner the union is opposed to cooperative purchasing unless it is carried on by an exclusively mutual organization. The reason for this is that in the past the unions have found "company stores" to be a prolific source of exploitation. The union is heartily in favor of first-aid facilities and of dispensary work, but is utterly opposed to systematic medical inspection. The reason for their opposition is that such medical inspection may be used to exclude the defective from employment, and as one leader put it, "increase the human scrap pile." When medical inspection is employed for the purpose of excluding the defective, it cannot be classed as welfare work, although such a proceeding may be justifiable in the interests of the employer and his customers.

There is one matter of which the union is very jealous, and that is what may be termed their fighting power. The union holds that the advantages which they secure must be won by "force," that is, by economic pressure. (This does not mean riot or disorder.) Accordingly, the union is very much opposed to any form of welfare activity which tends to limit their power in any way during times of industrial strife. Hence we find the union opposed to company housing on the ground that employes may be dispossessed during labor difficulties, and so find themselves without homes at a time when they are unable to pay their rent in advance. For the same reason unions are opposed to profit-sharing and benefit schemes unless the profits are paid in cash. The unions regard deferred profits or the ownership of equities in securities as a sort of bond retained by the employer to secure the good conduct of the employe.

The attitude of the unions on the question of profit-sharing is an interesting one. They appreciate the money but they do not like the way in which it comes. They would very much prefer to have the profits come to them in the form of an increase in wages for two reasons. In the first place, the moral pressure of such a wage increase would assist them in securing an increase elsewhere. In the second place, an increase in wages is usually a permanent thing, while a share in the profits may vanish whenever there are no profits to divide. They are opposed on principle to any system of profit-sharing in which the profits are confined to certain individuals, they object strongly to any investigation into the private affairs of their membership, and they feel that it is wrong to submit to any form of regulation or supervision by an employer or his agents, outside the walls of the factory.

It may be inferred, therefore, that the official union attitude is not entirely favorable toward the work of the Ford Co. While there is no complaint regarding the actual results of this company's welfare work, they maintain that the powers and privileges which the company are assuming may in other hands become highly dangerous to the welfare and even to the liberty of the workingmen, and it must be admitted that there is some measure of truth in this contention. They further allege that the unusual profits of the Ford Co. are obtained by a system of "driving." (That is, by the employment of highly efficient methods of production and by a high standard of diligence and industry in the work of the men.) They try hard to convince themselves that the output expected of the workmen is too great, and that such strenuous tasks will result in premature superannuation. Their real objection to "driving" however, is the fear that the general adoption of more efficient methods of work will throw large numbers of men out of employment, and reduce the wages of the remainder. This is an attitude of mind, however, which they are obliged to keep to themselves, for the reason that it is based on economic fallacy.

It may be pointed out that there is much to be said both for and against the Ford Co.'s methods. Their welfare work is in the hands of men who are deeply conscientious, and who are doing more in an endeavor to promote the welfare of their employes than any other firm has ever done. They are attacking some very grave social problems in a courageous and common-sense manner, and they have succeeded in obtaining at least a partial solution applying to the special case which they have in hand. On the other hand, we must recognize that both the leaders and the rank and file of union labor are thoroughly honest and conscientious in their convictions, that they have arrived at many of these convictions as a result of bitter experience, and that when these convictions are wrong it is because of a lack of knowledge of economics rather than a lack of willingness to see the right. The writer has sometimes thought that if every employer would give one hour a week to each employe for systematic instruction in the elements of economics and would himself devote the same time and study to the subject a great many of our labor differences would quickly die a natural death.

While we are discussing this subject, we must recognize that a part of the Ford Co.'s activities have nothing whatever to do with their industrial enterprise. In attempting to share the profits only with those employes who show a disposition to use them wisely, and in attempting to educate its workmen in the proper use of money, and in supervising their expenditures and methods of living, this company has made itself one of the philanthropic agencies of the community, and stands in the same relation to its employes as do the other organized philanthropic and social agencies. Were the profits of the Ford Co. divided as an increase in wages, it would be absolutely necessary for the welfare of the workmen to have some social agency undertake the kind of work which the Ford Co. does, and unquestionably it can perform that work much more effectively than any police court, social settlement, or any church or fraternal organization could possibly do. Without such instruction and supervision the high wages which the men would receive would sometimes be expended wickedly, often foolishly, and nearly always without receiving full value. There still remains, however, the possibility that this work might better be undertaken by a mutual organization such as the Filene Cooperative Association which has already been described, and which avoids in a very admirable way all the objections which may be raised against such activities on the part of an industrial corporation.

The attitude of the professional labor organizer toward welfare work sometimes becomes a matter of serious importance. It is the business of this class of men to secure certain things for the unions. Their bread and butter depend upon the service which they can render in this way. Like other men they are unwilling to see the source of their incomes destroyed, and while, in general, they labor for what they conceive to be the best interests of the worker, they are but human and therefore inclined to find fault with anything which weakens their power or appears to render their efforts unnecessary. These men are apt to look upon welfare work with divided feelings. They are in the position of an attorney who sees his client approached in an effort to settle his case out of court. While they are anxious to have everything possible done to promote the well-being of their clients (*i. e.*, the membership of the unions) they dislike to see anything which weakens their power or raises a question as to the value of their services. It is perfectly natural, therefore, that they should look upon many phases of welfare work with suspicion, and should believe that the employer by this means is attempting to undermine the influence of the union by developing in its membership a false sense of security and good-will.

Future of Welfare Work

It is beyond question that welfare work will become a permanent feature of our industrial life. This does not mean that all the features which we now include will remain in-

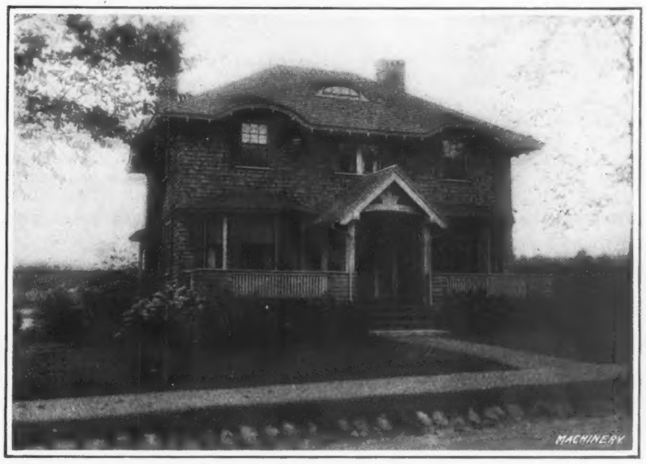
definitely, because many of them will vanish when changing conditions make them no longer necessary. The fundamental principles of welfare work, however, will remain so long as industry continues to exist on its present basis. Welfare work has its basis in the idea that it is the duty of the employer to utilize all the powers which he possesses—capital, initiative, judgment, and executive ability—to promote the welfare of the workmen whom he employs.

The social philosophy of the nineteenth century was highly individualistic. According to that philosophy it was the duty of every man to look out for number one. It was thought that if every man would exercise a reasonable amount of diligence and common sense in attending to this duty, the organization of society would be satisfactory, and that everybody would be as happy as could be expected. Welfare work found no proper place in this philosophy.

The social philosophy of the twentieth century, however, finds its basis in the advantages of cooperation. The new idea is team work. The coordinated and directed efforts of the minds and wills and wealth of many men are seen to be much more powerful in securing the welfare of the whole than are their individual efforts in securing the welfare of each. Hence modern social philosophy recommends organization and cooperation for the purpose of securing the general good. Welfare work is a manifestation of this spirit. Not only do we find employers using their powers for this purpose, but we find them organizing into associations with the idea of bringing their combined knowledge and experience to the service of their workmen.

As has already been stated, welfare work is only one of the many social agencies working for the betterment of the community. The work affects directly only those who are engaged in industrial work. It affects them for only a part of the time. In spite of its great importance, welfare work is one of society's minor agencies for good. It does its part in promoting the welfare of certain people and it does its part also in making the other agencies more effective. The knowledge and experience gained by the men engaged in welfare work become available for the other social agencies, and stimulate them to better and more effective efforts.

Welfare work is indicative of some new and promising tendencies in our industrial life. One of these is the tendency to be more thoroughgoing and painstaking in all matters pertaining to our social welfare, and particularly in the task of increasing our industrial efficiency. Another is the growing tendency to regard the primary purpose of industry as social service. The third is the ever-growing tendency to make society, in all its manifestations, more democratic. All of these tendencies are great with hope for the future. Through increased efficiency will come a larger measure of material satisfaction and comfort for the community. As industry becomes more and more an instrument of social service, society will be better served by it, and the present economic injustices which mar its administration will grow less. As industry becomes more democratic, the welfare and the wishes of workingmen will receive more and more consideration, and as a consequence they will gain a better knowledge of the laws of economics and the purposes of industry. This, in turn, will give to workmen a larger voice in the direction and control of industrial affairs, lead them to give efficient service more cheerfully and willingly, and enable them to share more equitably in the wealth which they create.



Figs. 30 to 32. Two-family Houses of the Better Grade provided for Employes by the Draper Co., Hopedale, Mass. These houses rent for about $3 to $4 per week per tenant.

Probably the most important, and at the same time the least appreciated effects of welfare work, are those which are indirect. The fact that an employer devotes systematic attention to the welfare of his employes is bound to awaken in his mind a new conception of the possibilities of community welfare. It is bound to give him a new vision of his social obligations. It is bound to call to his attention the enormous power for good which industrial leaders may exercise, especially when they are united in an association for this purpose. It is bound to give him a new and powerful light on those age-old social problems of whose solution we have made such a sorry mess. And out of it all are bound to come new social agencies of greater power and higher efficiency than those we now have.

Nor are the indirect effects on the working classes to be neglected. Welfare work means to them more than health and longer life and better conditions of employment. It means another generation of workmen, stronger, better trained, more intelligent, more efficient, more self-respecting. It means less bitterness and class consciousness, and more good-will and cooperation in our industrial relations. Following the example of their employer, they gain a new and clearer view of their social obligations. They gain new conceptions of family welfare and neighborly duty.

Copyright, 1915, by THE INDUSTRIAL PRESS
Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

140-148 LAFAYETTE STREET, NEW YORK CITY
51-52, CHANCERY LANE, LONDON, ENGLAND
Cable address, Machinery New York

Yearly subscription—$2.00; coated paper, $2.50; Foreign edition, $3.00. The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

NOVEMBER, 1915

NET CIRCULATION FOR OCTOBER, 1915, 22,433 COPIES

THIS number of MACHINERY is largely devoted to a review of safety and welfare work in manufacturing plants and selling organizations. We all know that the movement for better industrial conditions has spread over the country in a remarkable way during the past ten years, and evidences of "safety first" are to be seen on railroads, in steel works, in mines and other places where formerly there seemed to be an almost total disregard of the life, health and well-being of employes. The change is caused by an awakening to the fact that industry could not afford to go on year after year paying the enormous toll that carelessness and lack of forethought impose. It is not good business to kill efficient workers in the prime of life and leave their families destitute, to become burdens on the community. Nor is it good management to maim and cripple them, or to allow them to fall ill because of unsanitary conditions.

This great change has involved a vast amount of educational work among all classes, including men of every capacity, from the presidents of great corporations down to the humblest laborers. One of the chief principles to be inculcated was that an accident is not merely unfortunate—it is little short of criminal if avoidable or the result of carelessness. MACHINERY has consistently promoted the movement for years by publishing many articles written by men of practical experience in welfare work.

The movement for safer conditions in industry has spread with many ramifications, embracing almost every activity of life. One large employer of labor noted for his liberality to employes found that doubling wages was not sufficient to insure decent and healthful living conditions for his men. It was necessary to send out welfare workers to show them how to take care of themselves and their families. To what extent such paternalism is warranted is open to argument, but its immediate good effects can hardly be questioned. The impressive feature of an awakening industrial conscience is the realization that no longer are men and women regarded as subjects of exploitation only—they are to be regarded as co-workers whose unimpaired bodily vigor and health are assets of the community and must be conserved by every legitimate means to promote general welfare. As the author of the leading article points out, the change in the condition of workers as regards safety and housing is another evidence of the phase of social evolution through which we are passing. The employer of thousands stands in a somewhat different relation from the small employer, and that which may smack of paternalism, if carried on in a narrow way, has another and broader aspect when done on a large scale.

* * *

WHEN a manufacturer wants to purchase a machine tool his decision regarding the proper one to use is generally dependent upon several factors such as the productivity, cost of the machine, its adaptability to other manufacturing conditions besides that for which he is purchasing it, the power, strength and rigidity of the tool itself and its convenience of operation. If he already has a machine which is just about what he wants, his inclination is to order another of the same kind, although the one in use may represent an obsolete design.

Progressive manufacturers will refer to the mechanical journal on which they rely, and write to a number of advertisers therein for catalogues. Then comes the manufacturer's opportunity to make a showing in his catalogue that will impress the buyer. In some catalogues the inquirer finds complete details and tabulated information of the various sizes of machines, giving the range, feeds, speeds, horsepower, traverse and other necessary details. But in many catalogues the information is either very meager, or mingled with reading matter eulogizing the machines to such an extent that the inquirer may often read the entire catalogue before obtaining any real information.

The "talking points" of a machine should undoubtedly be set forth in a catalogue; but they are of secondary importance. Vital points in construction and operation and detailed information should come first, and in such forms that comparisons of various sized machines can be easily made. When arranged in this way the information forms a valuable reference which is appreciated by a prospective customer—and it pays the manufacturer.

* * *

WHEN a machine tool builder sells a new type of machine, or one differing radically from existing models of the same type, he usually sends a competent mechanic to superintend the installation and to see that the men who are to operate it fully understand its functions. The maker gives the service in order to insure having his machine properly installed and started under fair conditions.

In some cases, this service is being demanded of machine tool builders for standard machines; the buyers ask that the expense of installing new machines, even though they are of a well-known type already in use in the plant, shall be incurred by the maker. This is unwarranted and unjust. The manufacturers' prices on such machines seldom include the cost of installation, which, in addition to the traveling expenses of a competent mechanic and his pay while on the job, is often a considerable amount. A serious feature of this abuse of service, aside from the actual cost, is that in times when the demand for machines is very great, the best men must be sent out on installation work, as it will not do to send an ordinary mechanic. Only experts—men of good judgment, tact and considerable experience—are fitted for it. Mechanics of this type are scarce, and the demands of purchasers of machine tools for installation service puts a burden on the makers that they should not be expected to carry.

The practice is uneconomic and wasteful, and the National Machine Tool Builders' Association should discourage it. The price of standard machine tools should be fixed F. O. B. and demands for free installation on standard machines should be refused. Of course when a new type of machine is being developed and introduced, the rule may be modified, but at the option of the maker. The service should be regarded as a concession and not as a right.

* * *

Oil used for drawing the temper of hardened articles should be a mineral oil with a flash point of not less than 600 degrees F., this temperature usually being sufficiently high for the drawing of the temper of all ordinary tools. If higher temperatures are required, a mixture of two parts potassium nitrate and three parts sodium nitrate may be used for drawing temperatures up to 1000 degrees F.

Safety Organization of a Machine Shop

by Luther D. Burlingame*

ACCURATE records of accidents that occur in typical machine shops have now been kept for a sufficient length of time to show where the greatest dangers exist, also what are the hazards causing the greatest number of accidents and which of these are most serious. Thanks to the vigorous campaign for accident prevention now going on in America, as well as to the adoption of compensation laws in most of the manufacturing states, there has been a marked change for the better in accident prevention work and the way has been pointed out to a still further reduction of the number of accidents. The records which have been kept show the importance of safeguarding machinery, and on account of the steps taken in this direction the percentage of accidents resulting from such causes as unguarded gears or belts, and projections on revolving parts, has been materially reduced. Fig. 2 shows the proportion of accidents from various causes occurring in the Brown & Sharpe works last year, from which the comparatively small percentage of mechanical accidents will be noted; it will be seen that the majority of accidents are non-mechanical, and that most of these are caused by falling, being struck by falling objects, or having the eyes injured by flying chips.

This plainly shows where the greatest efforts should be made toward further accident reduction; and these efforts should take the form of an endeavor to inject the "safety spirit" into the working force, so that men will be more thoughtful of their own and others safety. In this way the non-mechanical accidents, many of which have been classed as "unavoidable," will be avoided or at least greatly reduced in number. Such a reduction has invariably been found to follow in the shops in which it has been possible to instill the safety spirit and to continually keep the subject before the workmen. It is believed that even though only a small proportion of shop accidents are directly attributable to unguarded machinery, thorough work in guarding these hazards is not only of help in avoiding such accidents as being caught in machinery, but is also of great help in keeping the matter of safety before the men and indicates a willingness on the part of the management to do its full share toward preventing accidents.

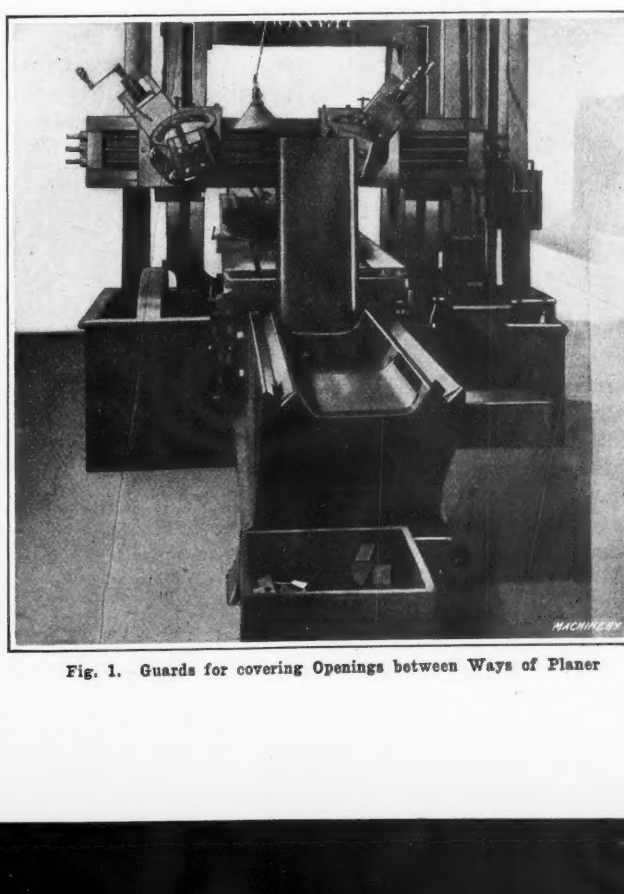


Fig. 1. Guards for covering Openings between Ways of Planer

Mechanical Safeguards

It is not the purpose of this article to give a comprehensive survey of mechanical safeguards as used in the machine shop, but rather to dwell upon methods of reducing the number of non-mechanical accidents which are of so much more frequent occurrence and of so much more serious character than the so-called "mechanical accidents." A few examples of mechanical guarding and mechanical means of preventing accidents are given, however, largely to indicate what can be done for orderliness, cleanliness, etc.—factors upon which greater stress should be laid when considering the question of accident prevention. Fig. 1 shows a set of guards for covering the openings between the ways of a planer. While the hazard of being caught by the platen of a planer when the hand is in one of these pockets is rather remote, such accidents have occurred and the guards not only prevent their recurrence but also tend toward neatness and cleanliness in keeping the spaces clear of rubbish. Another illustration of a device to serve the same purpose of orderliness is shown in Fig. 3, which illustrates a rack of the kind provided in each department for the storage of ladders when not in use. This view also shows methods of piling and storing unfinished work, a fire extinguisher on the wall and a safety door for the elevator designed in such a way that if the door is left open or even ajar the elevator cannot move from the landing until the door is closed.

Exhaust Systems

Exhaust systems to carry off dust from grinding and polishing machines, as well as metal chips, sawdust, etc., are coming more and more into use. While the prime motives for such installations are the protection of the workman's lungs and eyes, and the protection of the machine from

* Industrial superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

Proportion of Accidents from Various Causes at Brown & Sharpe Works in 1914

MECHANICAL ACCIDENTS, 18%.. Caught in or injured by machinery.	5.4%	Caught between tool and work and in similar places where guarding is not practicable.
	6.2%	Cuts and injury from grinding wheels.
	6.4%	Caught by gearing, etc., where guarding might prevent.
NON-MECHANICAL ACCIDENTS, 82%* Not due to machinery or lack of guarding, and where care on the part of workmen can be the largest factor in reducing accidents.	33%	Workman's falling, or object falling on workman Strains lifting, etc.
	16%	Flying chips, emery, etc., including injury to eyes.
	19%	Cuts with sharp instruments or edges.
	5%	Jams and hammer blows.
	3%	Wrenches slipping.
	3%*	Projecting nails or splinters.
	3%	Miscellaneous.

*Here is the greatest opportunity to make a reduction in accidents during the coming year.

Fig. 2. Proportion of Accidents from Various Causes which occurred in the Works of the Brown & Sharpe Mfg. Co. during 1914

wear, there is also an important advantage in bringing about a condition of cleanliness which expedites the work and reduces the accident hazard. Where it is not found possible to install a complete exhaust system, individual exhausts can be applied to the machines, as shown in Fig. 4 for a surface grinding machine and in Fig. 5 for a cylinder grinding machine. Fig. 6 shows an automatic gear-cutting machine cutting cast-iron gears, on which an exhaust system is employed so that the dust and chips are carried away. This is not only of advantage to the bearings of the machine and the lungs of the workmen, but the cooling effect produced by the air current keeps the cutter clear of heated chips and makes it possible to nearly double the production without affecting the accuracy of the work. In striving for cleanliness and orderliness it is of assistance to have white lines painted on the floor to mark

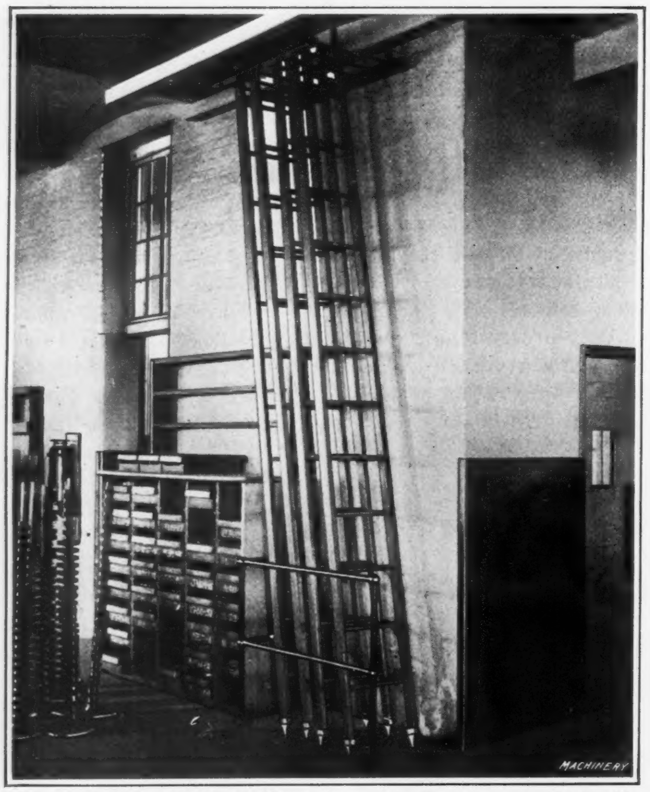


Fig. 3. Rack for holding Ladders when not in Use; it serves the Double Purpose of providing for Safety and Neatness

the aisles which are to be kept clear of obstruction. This is of direct help in keeping a clear path for trucking, as well as in constituting a safety feature. If an obstruction, such as a long piece of work held in a machine, protrudes over a passageway, a piece of white paper or cloth should be hung on the projecting part to attract the attention of passersby, thus serving as a warning. Fig. 7 shows such a piece of work with a newspaper hung over it.

Punch Press Safety Methods

One of the first problems that were taken up for study a few years ago, when the Brown & Sharpe Mfg. Co. made a comprehensive survey of the accident problem, was the prevention of accidents in punch press work. Although strict instructions had previously been given to have the work done in a safe way, accidents continued to occur. After studying the situation it was decided to provide means so that the work could be done without the necessity of putting the hands between the punch and die in handling the work. This plan was carried out and various means have been devised so that practically all of the work can be handled as economically as by the old method of using the hands, and with no danger of injury to the workmen. One of the means devised calls for the use of tweezers for inserting the work and a brush, stick or other device, if needed, for removing it from the die; a chute has usually been found to be the best means for inserting the work, using a stick for removing it; another means consists of the use of a sliding die-bed so that the hand can place the work in position when the die is out from under the punch, and then the die-bed can be slid back into position for performing the operation. This sliding die-bed is shown in Fig. 8.

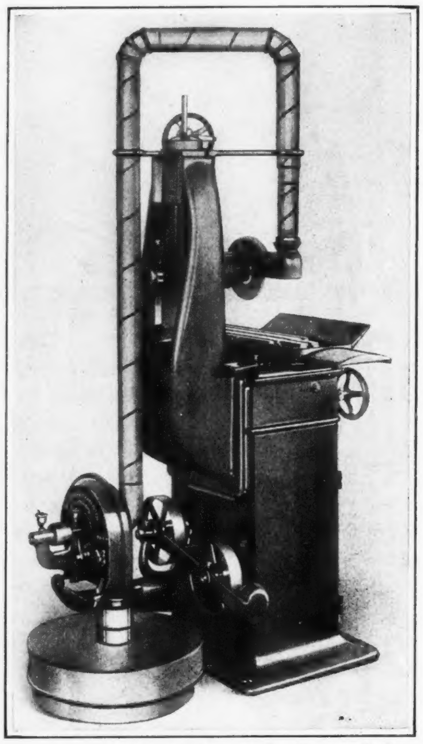


Fig. 4. Individual Exhaust System applied to Surface Grinder

One of the punch presses has also been fitted with a guard which automatically drops when the press operates, and which prevents the descent of the ram if any obstruction like a man's hand is in the way. This was provided for work which it was thought could not be done to advantage by either of the methods already described.

Clearing Chips from Revolving Cutter

One of the most frequent of mechanical accidents has been in the operation of milling machines, due to catching the fingers between the revolving cutter and the work when wiping away the chips. Even when brushes are provided for this purpose it requires constant vigilance and the exercise of discipline to secure their use and prevent these accidents. One way which has been devised to keep the chips

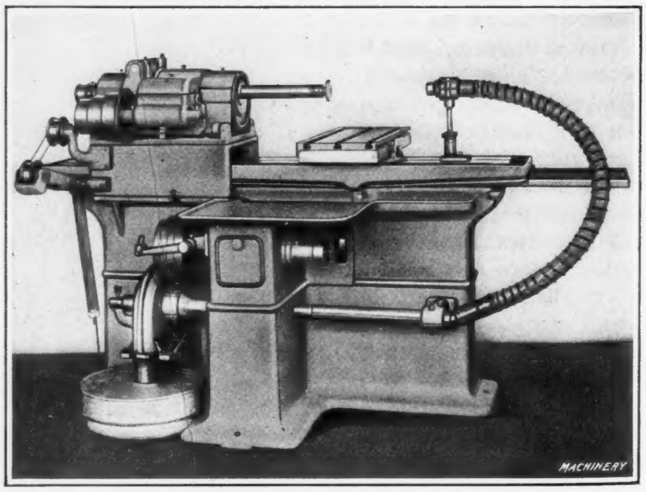


Fig. 5. Cylinder Grinder equipped with Individual Exhaust System

cleared away is to provide an auxiliary flexible pipe connected with the system supplying the cooling fluid, so that by pressing a push-button a stream under sufficient pressure to wash away the chips can be directed upon the work. Fig. 9 illustrates the application of this idea.

Means for Reducing Non-mechanical Accidents

Among the means for reducing accidents in general, with special reference to non-mechanical accidents, the following are of importance:

1. Securing statistics and figures to show just what kinds of accidents are occurring, their degree of seriousness and in what departments accidents are most frequent.
2. Impressing upon the department heads and foremen that they have a responsibility in the prevention of accidents, and seeing that they try to stimulate interest in the prevention of accidents among their sub-foremen and workmen.

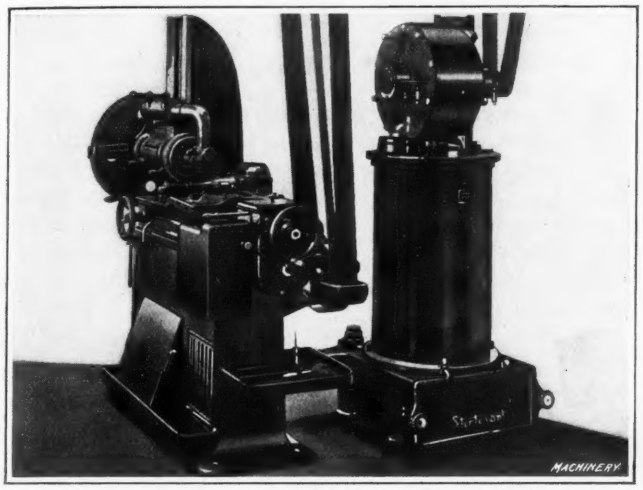


Fig. 6. Automatic Gear-cutting Machine with Exhaust System to carry away Chips and Dust

3. Reaching the workmen themselves through literature, safety meetings and posted notices, so as to impress them with the importance and need of safe methods of working.
4. Providing for regular safety inspection in order to see that means for safety are provided and used and that danger points are done away with.
5. Providing "first aid" and taking care of all cases of accident promptly so as to prevent their developing into serious cases through infection or otherwise.

In order to secure statistics in regard to accidents, full records of every accident should be kept on printed forms; and these should be reviewed each week so that steps can be taken promptly, in case a remedy is needed, to avoid a repetition of the same kind of accident and to place the responsibility if there is cause for blame. Sometimes these records disclose interesting entries as, for example, one where, in the case of a severe bruise, there was entered on the report under "Remarks:" "There were some but they were not proper to be set down." The statistics gathered from the accident reports can be classified and put in the form of monthly reports, arranged according to departments and to the kinds of accidents, showing in what departments the conditions have been growing worse, and from the nature of the accidents where attention is needed in taking further steps for accident prevention. By tabulating these every few months and obtaining percentages, the actual situation can be laid before the safety committee and the foremen at frequent intervals, without waiting for the annual report.

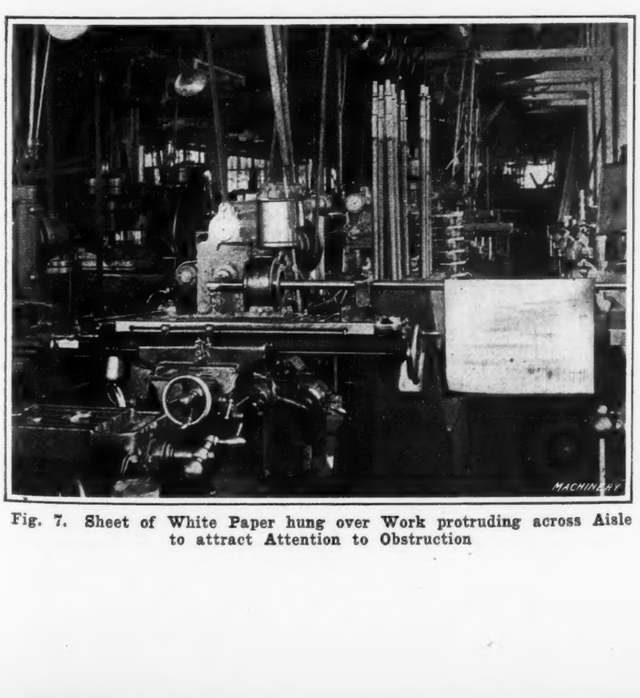


Fig. 7. Sheet of White Paper hung over Work protruding across Aisle to attract Attention to Obstruction

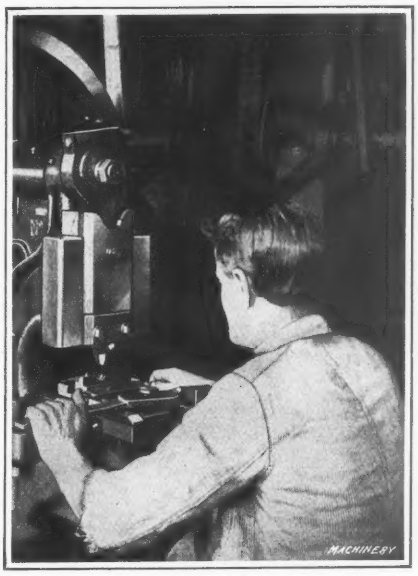


Fig. 8. Application of Sliding Die-bed to provide against Accidents

The annual report gives statistics regarding accidents for a sufficiently long period to give a fair average of conditions, both as to the standing of the departments and as to the kinds of accidents most frequently occurring. It was found, however, that such figures did not give a fair indication as to just how much effort was being made to provide for the safety of employes and what interest was being taken in reducing the number of accidents in the various departments, because the hazard was so much greater in some departments and for some kinds of work than for others, and because the departments varied so greatly in size. For this reason, the posted notices would keep a dangerous department always on the very bad list, even though a more intelligent and more determined effort was being made in such a department to reduce the number

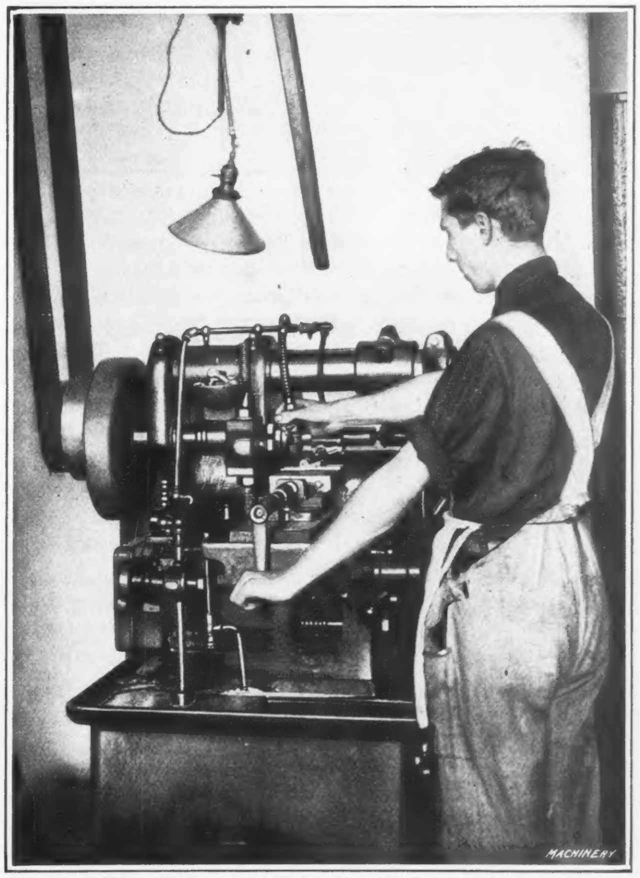
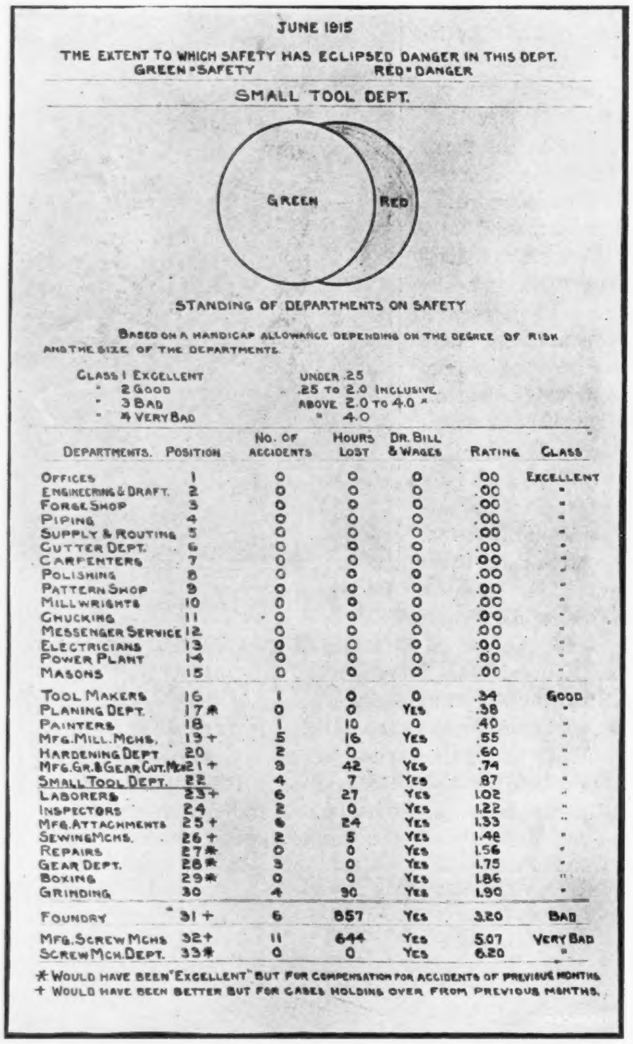


Fig. 9. Milling Machine provided with Auxiliary Lubricant Tube for supplying Flow of Cutting Compound to wash away Chips


JUNE 1915

THE EXTENT TO WHICH SAFETY HAS ECLIPSED DANGER IN THIS DEPT.
GREEN = SAFETY RED = DANGER

SMALL TOOL DEPT.

STANDING OF DEPARTMENTS ON SAFETY

BASED ON A HANDICAP ALLOWANCE DEPENDING ON THE DEGREE OF RISK AND THE SIZE OF THE DEPARTMENTS.

CLASS 1 EXCELLENT	UNDER .25
" 2 GOOD	.25 TO 2.0 INCLUSIVE
" 3 BAD	ABOVE 2.0 TO 4.0 "
" 4 VERY BAD	" 4.0

DEPARTMENTS.	POSITION	NO. OF ACCIDENTS	HOURS LOST	DR. BILL & WAGES	RATING	CLASS
OFFICES	1	0	0	0	.00	EXCELLENT
ENGINEERING & DRAFT.	2	0	0	0	.00	"
FORGE SHOP	3	0	0	0	.00	"
PIPING	4	0	0	0	.00	"
SUPPLY & ROUTING	5	0	0	0	.00	"
CUTTER DEPT.	6	0	0	0	.00	"
CARPENTERS	7	0	0	0	.00	"
POLISHING	8	0	0	0	.00	"
PATTERN SHOP	9	0	0	0	.00	"
MILLWRIGHTS	10	0	0	0	.00	"
CHUCKING	11	0	0	0	.00	"
MESSENGER SERVICE	12	0	0	0	.00	"
ELECTRICIANS	13	0	0	0	.00	"
POWER PLANT	14	0	0	0	.00	"
MASONS	15	0	0	0	.00	"
TOOL MAKERS	16	1	0	0	.34	GOOD
PLANING DEPT.	17*	0	0	YES	.38	"
PAINTERS	18	1	10	0	.40	"
MFG. MILL. MCHS.	19+	5	16	YES	.55	"
HARDENING DEPT	20	2	0	0	.60	"
MFG. GR. & GEAR CUT. MCH.	21+	9	42	YES	.74	"
SMALL TOOL DEPT.	22	4	7	YES	.87	"
LABORERS	23+	6	27	YES	1.02	"
INSPECTORS	24	2	0	YES	1.22	"
MFG. ATTACHMENTS	25+	6	24	YES	1.33	"
SEWING MCHS.	26+	2	5	YES	1.48	"
REPAIRS	27*	0	0	YES	1.56	"
GEAR DEPT.	28*	3	0	YES	1.75	"
BOXING	29*	0	0	YES	1.86	"
GRINDING	30	4	90	YES	1.90	"
FOUNDRY	31+	6	857	YES	3.20	BAD
MFG. SCREW MCHS	32+	11	644	YES	5.07	VERY BAD
SCREW MCH. DEPT.	33*	0	0	YES	6.20	"

* WOULD HAVE BEEN "EXCELLENT" BUT FOR COMPENSATION FOR ACCIDENTS OF PREVIOUS MONTHS.
+ WOULD HAVE BEEN BETTER BUT FOR CASES HOLDING OVER FROM PREVIOUS MONTHS.

Fig. 10. Reproduction of a Copy of one of the Safety Reports. Such Copies are posted in Each Department of the Factory

of accidents than in one where the hazard was much less or which was smaller, but which was reported good.

In order to equalize these differences a handicap plan was devised so as to take into account both the degree of hazard and the number of employes in each department. The handicap allowance determined on was as 8 to 1 between the extreme departments, the foundry and wood-working departments being rated at 8 while the drafting and engineering departments were rated at 1. As the foundry employs practically three times as many men as the combined drafting and engineering departments, this gave a ratio of 3 by 8 or 24 to 1 between these departments, so that 24 accidents occurring in the foundry would be equivalent to one occurring in the drafting and engineering departments. The other departments were rated between these extremes, all general machine departments being rated at 5. By the use of formulas, the relative rating for the departments could be obtained by the month, the year, or for any other period. The matter of lost time and compensation or doctor's bills is also taken into account in obtaining a rating of the departments, the proportion being that one accident is considered equivalent to twelve hours lost time, or to \$2.50 compensation or doctor's bills. The yearly rating is obtained by the following method: A constant factor is found for each department by the formula:

$$\frac{10}{\text{Number of employes} \times \text{handicap factor}} = \text{constant factor.}$$

[Number of accidents + (hours lost ÷ 12) + 0.4 expense in dollars] × constant factor = yearly rating.

Example:

Number of employes in department....	364
Handicap factor	8
Number of accidents in one year......	40
Number of hours lost..................	2557
Doctor's bills and compensation........	\$247

$$\frac{10}{364 \times 8} = 0.0034 = \text{constant factor.}$$

$$\left(40 + \frac{2557}{12} + 0.4 \times 247\right) \times 0.0034 = 1.20 = \text{yearly rating.}$$

The classification is as follows: Ratings under 0.25, excellent; 0.25 to 2 inclusive, good; 2 to 4 inclusive, bad; over 4, very bad. In the above example the standing would thus be good. The formulas for the monthly reports are such as to give the ratings on the same basis. The monthly reports naturally fluctuate more on account of the short period covered, and in a small department, especially if the handicap is low, a single accident may put it well down on the list. The monthly reports are posted in all departments of the factory, showing each department, its standing for safety and how it compares with other departments. Such a report reproduced is shown in Fig. 10. Green and red disks are placed at the top of each of these reports, the green disk covering the red to the extent to which safety has eclipsed danger during the past month in that particular department. The name of the department is entered above, and, at a glance, it can be seen what its standing is.

In the case of accidents where there is absence from work for several months and compensation to be paid for such a period, it sometimes brings about the condition that a department is classed as "bad" or "very bad" for a month, when no accidents have occurred during that time, because of payments for accidents that occurred in previous months. Such cases are indicated on the report and explained by a foot-note. The posting of these reports introduces an element of competition which has a stimulating influence on foremen and workmen in making them try to have their department stand well, and the fact that a handicap is allowed for the more dangerous and larger departments does away with the claim of unfairness which resulted from the posting of earlier reports before such a plan was put into effect. The yearly reports are also put into a form which

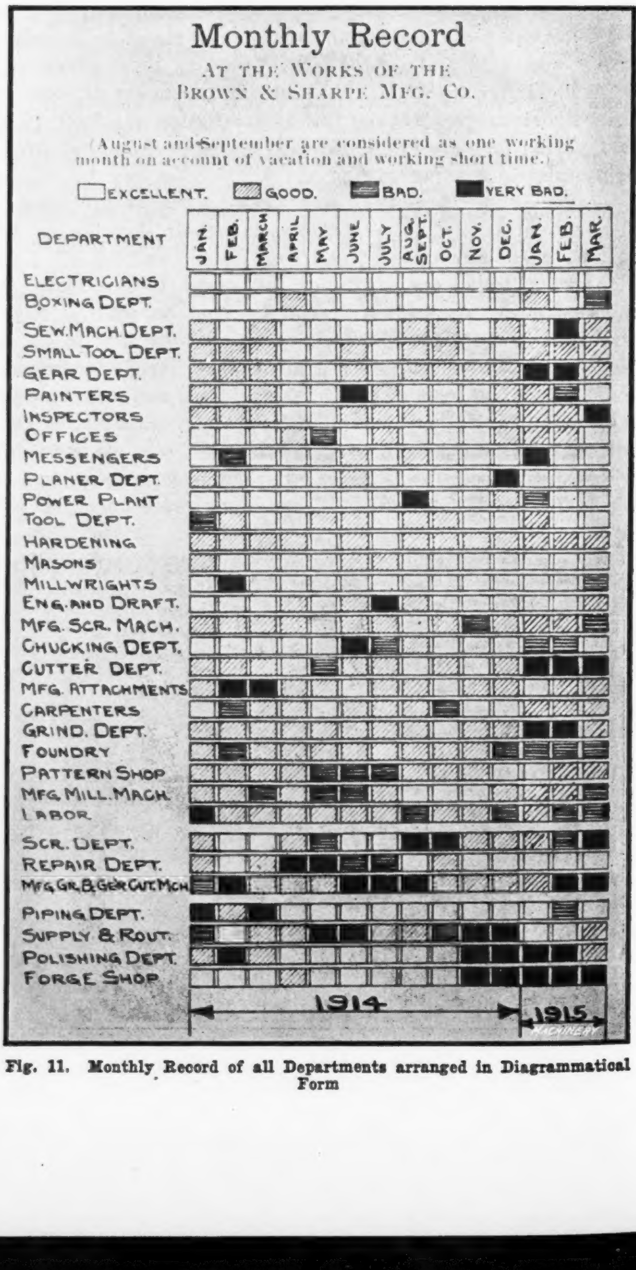


Fig. 11. Monthly Record of all Departments arranged in Diagrammatical Form

presents the standing of departments, month by month, in diagrammatic form, as shown in Fig. 11. This is of value in showing whether a department has just averaged good through a long period or whether it has been excellent most of the year and then been brought down by just one bad month. In the case of a small department with a low handicap, one bad accident will spoil its record for a long time. This was the fact in the case of the forge shop given last on the list in Fig. 11, where one eye accident resulting in the loss of an eye put this department at the bottom of the list, although through a large part of the year it had been rated as "excellent."

The annual report is also posted in diagrammatic form, presenting the relative standing of departments during the year, as shown in Fig. 12. On this poster there also appear notices of especially good records made by some of the departments. Copies of large size are conspicuously displayed in those particular departments, showing where they have made a great gain or for other reasons should be commended for good work in safety. In the case of the foundry, a notice like that shown at the bottom of the group of notices in Fig. 12, was posted to impress the workmen of that department with the gain that had been made in reducing burning accidents following the insistence upon the wearing of "congress" shoes and leggings while pouring off. Such a showing helps to disarm criticism from men who think the old way is good enough for them, by showing the real gain resulting from accident prevention work.

Fig. 13 shows a workman equipped with congress shoes and leggings, pushing a wheelbarrow equipped with handle guards through a pair of swinging doors. These handle guards, shown just outside of the workman's hands, allow the wheelbarrow to be pushed through the doors without danger to his arms or hands when the doors swing back. Besides the posting of special safety notices, the workmen are given instructions in regard to working in safe ways by means of a booklet entitled "Health and Safety" which

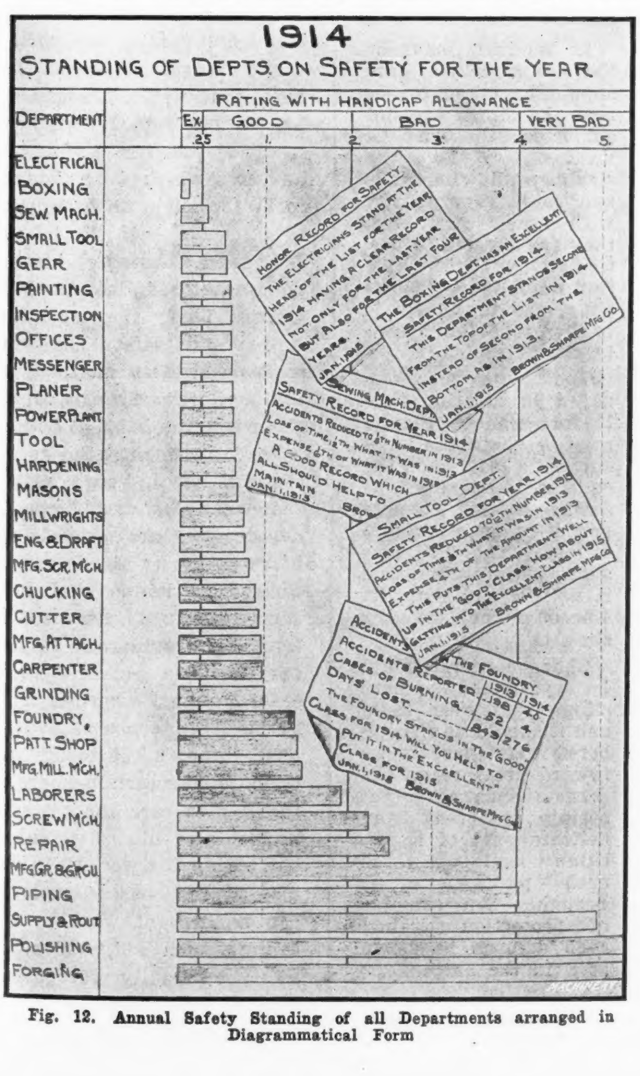


Fig. 12. Annual Safety Standing of all Departments arranged in Diagrammatical Form

Fig. 13. Foundry Employe wearing Congress Shoes and Leggings, and pushing a Truck provided with Handle Guards

is distributed to all Brown & Sharpe employes, and this is supplemented by instructions from the foremen and members of the safety committee as to safe methods of working. In the case of the apprentices, special instructions for safety are also given in the school-room during class hours. One way to give definite instructions as to safe ways of handling machines when moving them about is to photograph them when properly hung in a rope "sling," and indicate in each photograph the points to be looked out for. Fig. 14 shows such a photograph, and also a diagram and description showing the varying strain on a "sling," this data being taken from "Health and Safety."

Safety Committees

The responsibility for accident prevention work at the factory of the Brown & Sharpe Mfg. Co. is placed in the hands of a committee of three, representing the industrial, engineering and machine departments, with a secretary to carry on the work and look after the necessary details. Under the direction of this safety committee, there is a committee composed of foremen and workmen, one member from each of the main floors and departments, making a total of about thirty men who act in groups as sub-committees for each building, there being five or six men in each of these groups. These safety inspectors, as they might be called, are responsible for safety work in their respective departments, and countersign all accident reports which are sent in. They make suggestions on printed slips of the form shown in Fig. 15, which are in book form with provision for keeping carbon copies. The importance of this part of the work is emphasized in a report made by William H. Doolittle, safety inspector of the National Metal Trades Association, who, following a recent inspection of the Brown & Sharpe works wrote: "Most important of all in our opinion is the working of the safety system—the system that provides a safety man for each floor of the building, carrying with it perpetual inspection of the plant and bringing practical suggestions directly to the central head of the general system. The stimulation of the department spirit by posting comparative tables showing the standings of the different departments is a helpful feature of this system." Following are some extracts from the instruc-

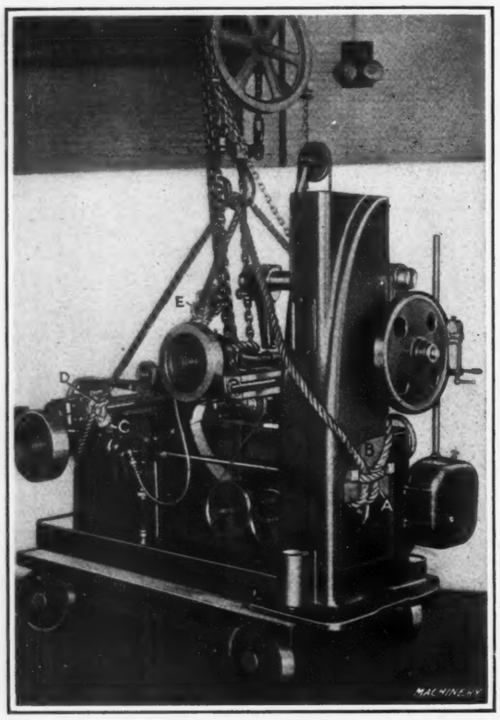
tions given to members of the Brown & Sharpe safety committees and points to be observed and reported by them.

Instructions for Members of Safety Committees

The subcommittees will each represent a building or group of departments, and in the main buildings there will be one member of the committee from each floor. These members will be appointed by the general committee on the first of January of each year to serve for one year, subject to removal by the general committee, which shall also have power to fill vacancies. As a member of one of these subcommittees it will be your duty to look after matters of safety on your floor or in your department, and it will be your duty to make suggestions for safeguarding, using the forms in the book provided for that purpose. Any suggestions which you have to make, or which are made to you by fellow-workmen, and which in your opinion are worthy of attention, should be forwarded at once to the secretary of the general committee, so that anything which demands immediate attention can be taken care of promptly. All accidents occurring in your department should be brought to your attention so that you can see whether steps can be taken to avoid their recurrence. Aside from the regular inspection you should be alive at all times to conditions of danger. After your period of service on the committee has expired, it will still be your duty to make further suggestions at any time as to safety. The committee representing each building will meet together and make an inspection of that complete building once in three months, comparing notes and getting the benefit of each others experience and suggestions.

Some General Points to be Observed and Reported by Members of the Safety Committee

1. Report all exposed gears where workmen may be caught.
2. See that guards provided for grinding wheels are used, and that wheels have soft collars to clamp on.
3. Report when high-speed belts near the floor are not guarded.
4. Report when any mechanism is such as to allow the workman to be caught or pinched.
5. See that there are no projecting set-screws or other projections on exposed revolving parts.
6. See that work is so piled as to prevent falling, and that passageways are kept clear.
7. See that there are no projecting nails, splinters, etc.
8. Report broken glass in doors, etc.
9. Report cases where apprentices, also operatives of machines under twenty-one years, do not wear short-sleeved jumpers.
10. See that loose or ragged sleeves, hanging neckties, etc., are avoided. Loose rags should not be used on the fingers by workmen operating machines.
11. Report any parts overhead which may become loose and fall on workmen.
12. Report any workmen working in an unsafe manner and taking unnecessary risks.
13. See that unsafe methods of holding work in chain hoists or rope slings are avoided.
14. See that the fingers are never used for wiping chips from work in milling machines, etc.
15. See that eye protectors are used in departments where there is danger to the eyes.
16. See that guards and other means of safety are used. This refers to guards on woodworking machines, etc.
17. See that padded aprons are used in woodworking departments when using slitting saws.
18. See that circular and band saws, also buzz planer knives, are kept sharp.
19. See that congress shoes and leggings are worn in the foundry when pouring off.
20. See that workmen do not work under a heavy suspended weight without using "horses."
21. See that all electrical work, switches, etc., are properly guarded.
22. See that fingers are never put between the punch and die on presses, or in any other similarly dangerous place.
23. See that pipes on screw machines are up close to the machine so as not to leave exposed revolving stock.
24. See that wrenches are in good condition.
25. Hang white paper on any exposed part which projects into a passageway.



Method of handling a Machine by Means of a Rope "Sling"

A, block of wood so applied as to avoid chafing or cutting of rope; B, leather so applied as to avoid chafing or cutting of rope; C, wooden block back of shaft to avoid springing it; D, cloth to protect shaft and rope; E, extra knotting of rope as a precaution against slipping.

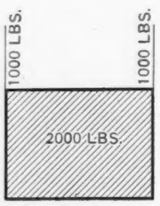


Fig. 1

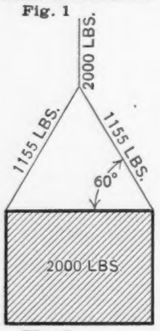


Fig. 2

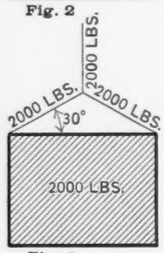


Fig. 3

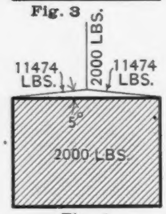


Fig. 4

SLINGS FOR HOISTING

In handling loads by the use of slings, care should be taken to see that the slings are not subjected to undue strains. While the strains coming on slings and ropes vary greatly with the conditions, they are affected in particular by the inclination or obliquity of the sling, and the strain is in the proportion shown by the diagrams.

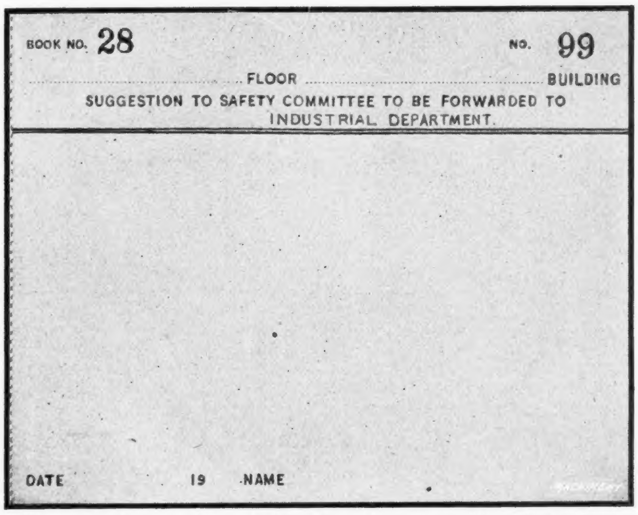
Too often men engaged in hoisting take it for granted that a rope or chain that will support a load when the ends are vertical will be strong enough to support it under other conditions. The diagrams show plainly that this is not so, and that No. 4 needs a much stronger sling than No. 1.

Sharp corners should be protected where slings pass over them and it should be remembered that there is an inward pressure on the corners such as might spring or break any delicate part of a machine against which such pressure is brought. An example of protection against such damage is shown at *C* in the half-tone.

Fig. 14. Instructions to be followed when moving Heavy Machinery in Factory

Importance of Proper Medical Attendance

In spite of care taken to have first aid given in all cases of even minor importance, some of the heaviest expenses in the past have been in cases of neglected scratches and cuts which were thought to be too slight to be worthy of attention but which have afterward become infected and developed into serious cases. This, like all other branches of safety work, requires education on the part of the workmen so as to get them into the habit of having such injuries attended to no matter how slight, rather than take chances. First-aid departments are provided throughout the Brown & Sharpe works so that help can be obtained with the minimum of trouble. A dispensary is also provided at a central point, where a male nurse is in constant attendance; and a physician attends during certain hours of the day to care for cases of accidents or illness which occur within the works. In the majority of cases employes can be kept at work by obtaining such aid, which, as will be readily recognized, will be to their own as well as the company's advantage.


BOOK NO. 28 NO. 99
.... FLOOR .... BUILDING
SUGGESTION TO SAFETY COMMITTEE TO BE FORWARDED TO INDUSTRIAL DEPARTMENT.

DATE 19 NAME

Fig. 15. Form used by Safety Inspectors in making Suggestions concerning Improvement of Conditions in Factory

Many interesting questions arise as to how far to go in giving help to workmen along the lines of medical treatment, and as to where to draw the line in cases of compensation. Some such questions are as to whether accidentally breaking the workman's false teeth or his eye glasses in the shop can be classed under personal injury; also, as to whether a man suffering from boils on his arm should be cared for and paid compensation on the theory that the boils might have occurred from oil used in connection with his work. Cases of rupture often raise a question of doubt as to whether the man's condition was caused by, or had any connection with, his employment in the shop. The feeling among manufacturers seems to be that in a general way compensation laws are a help in creating a better feeling between workmen and employers, and result in the money paid out for accidents going to cases where the help is really needed and where in justice it should go, as compared with past experiences where so much went for litigation.

Periods of industrial activity, when there is much overtime work and when a great many new men are employed, increase the accident hazard materially and greater efforts must be made if the accidents are to be kept down. In our own case, recent accidents have been in the proportion of more than 4 to 1 among new men, as compared with those men who have been for more than six months in our employ. This condition exists in spite of efforts which have been made to instruct new men in matters of safety. The percentage of accidents among men working overtime has also been many times greater than among those working regular hours. Curiously enough, however, very few of these accidents have occurred during the overtime period. This whole safety question is one which must be constantly followed up—one which will not take care of itself after it has once been "tuned up" to a point where good results are being obtained. It is not believed that the goal has by any means been reached, but that the safety spirit and safety methods can be developed and extended in the future so as to still further reduce the number of shop accidents. Technical societies and the technical press are rendering direct and invaluable assistance by keeping this matter of accident prevention constantly before the attention of manufacturers and the employes in their factories.

* * *

OFFICE MANAGEMENT

BY J. P. BROPHY*

Did you ever enter an office and gaze in amazement at the number of employes engaged therein, all apparently busy? Then perhaps you think of your own place of business and make mental comparisons. Possibly your own office might contain twice as many employes, or perhaps not half the number. Whichever it might be, it would set you to thinking seriously, especially if the number in your office were large compared with that in the office you were visiting.

*Vice-president and general manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

There is no question but that work in offices has not kept pace with the manufacturing end of many lines, and the waste because of inefficient management is in some instances enormous. Proper classification of employes according to their qualifications is just as essential in office work as in the producing end of the business.

The proper assigning of work according to each individual's ability is a matter to be seriously considered, and this is uppermost in the minds of those who are using the efficiency system or otherwise producing your product at a minimum. This being a fact, why neglect the clerical end? In some cases a man is overcrowded, whereas another individual is not doing half a day's work. Planning office work requires good management, and laxity means disorder and many times irreparable mistakes because blunders in office work are often conveyed to the other fellow by Uncle Sam.

There is no question but that hundreds of offices are overcrowded with help just because the man in charge is not capable. Mismanagement in this respect is apparent in many cases, and one of the primary reasons for this is in the distributing of the work and failing to arrange things so that each one is kept comfortably busy throughout the day.

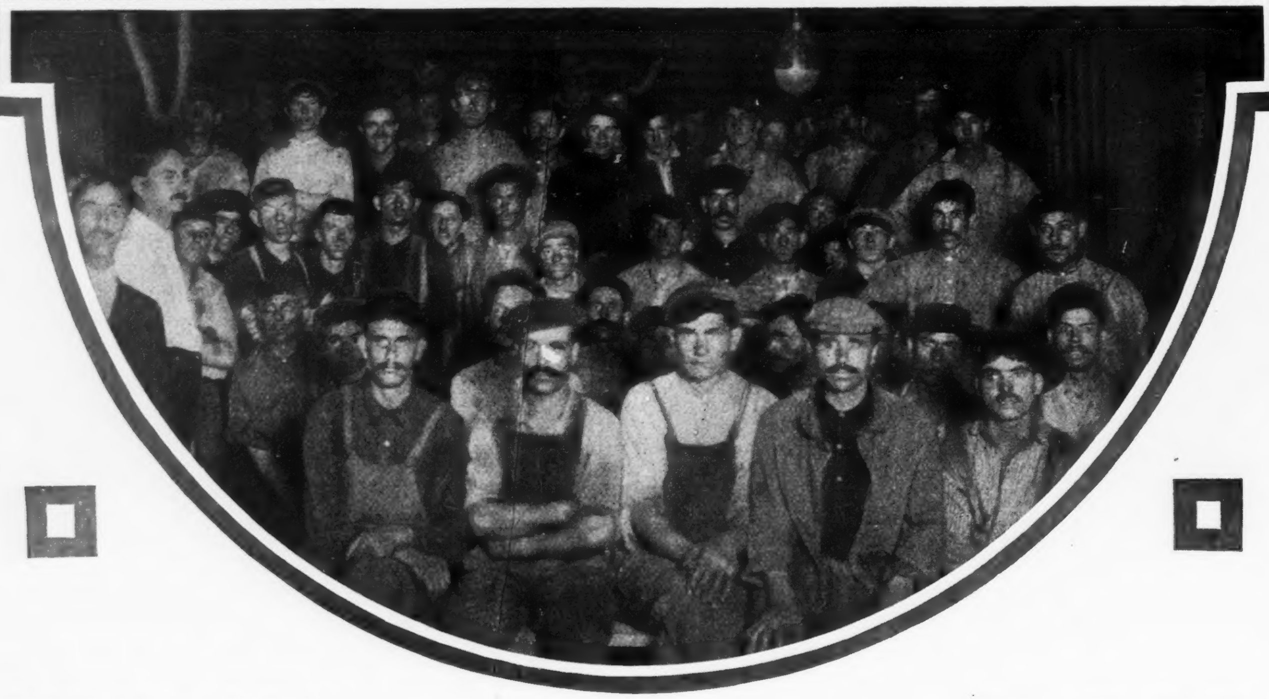
In many cases the manager of an office is not capable; sometimes through recklessness because of his affiliation with the business, because of a money consideration, or for the reason that the cost of operating an office seems to be lost sight of. An office man who has not enough to keep him busy and lags and becomes indolent and loses his ambition. What is the result? Mistakes. An inactive brain through the absence of anything to do never develops properly. There is no line of business where mistakes are made easier on account of not being kept busy than in an office.

You may be strict as to what your employes should and should not do, over-cautious that they do not talk too much to each other, exceptionally particular that they reach their place of business on the minute and stand for no nonsense, but if you are not genuinely capable of judging what a day's work is, you are bound to have an unbalanced working force.

One great fault can be found with the slowness in distributing the mail in the morning. If the man who has this in charge takes his time in the extreme, the distribution of the mail to the clerical help is slow, the best part of the morning is wasted and the employes are actually idle. The one who handles the mail should be vigorously on the job at the right time, and if the mail is exceptionally large he should have an assistant. All letters should be opened promptly and handed to those for whom they are intended.

Writing letters in an office should be done as early as possible, not fooling the time away in the morning and commencing this work in the afternoon. If the correspondence is put off until the afternoon the mail that should be answered today is not answered until tomorrow, and before you know it you have a vast number of letters a week old that have not been replied to. You suddenly find that there is an accumulation of such things, and in trying to catch up the whole office is in turmoil. Then it appears that you have not half enough help, whereas the trouble lies in not punctually replying to all communications. Punctuality means less help and better work because everything is fresh and taken care of in the proper manner. It is the indifferent way of doing things that causes all kinds of misunderstandings and creates the feeling that you actually require more help, whereas if the work were well done, you could do with less.

In producing anything, costs are uppermost in the mind of the manager. If the costs are high, an investigation is in order, but in the office nothing of this kind seems to enter the minds of those in charge. Useless commands are given; the help in numerous cases please their own fancy as to what they should accomplish. If important things are delayed, the excuse is "I was too busy to attend to it". The office manager in many instances believes what is told him because unquestionably he is not in close enough touch to discriminate between the employe who is efficient and the one who is always dilatory. It seems in many cases to be a do-as-you-please proposition. There is satisfaction in cleaning up the desks every night. Without system time is lost and energy wasted.



Safety and Welfare Work in an Electrical Plant

by Chester L. Lucas*

THE General Electric Co. in all its plants has been particularly active in general welfare work and especially in the promotion of preventative work for the elimination of accidents. A central safety committee is maintained with headquarters at the Schenectady, N. Y., plant, and members of this committee are located in each of the other plants at Pittsfield, Mass., Lynn, Mass., Harrison, N. J., and Erie, Pa. This article will describe the activities in this direction at the Pittsfield plant.

The mediums by which the work is carried on consist of a safety inspector, whose duty it is to locate all dangerous spots and unguarded machines in the factory and see that they are properly guarded; lectures on safety to foremen and other employes, impressing the necessity of care in their particular vocations; a hospital where all minor injuries are treated and the general health of the employes is looked after; and a monthly newspaper giving the news of the factory in an interesting way, and at the same time weaving in matter to emphasize the importance of paying attention to safety measures.

The Safety Inspector

In a plant employing four thousand men, the duties of a safety inspector are manifold. There is the need of continually looking through the different factory buildings, locating the dangerous spots, and seeing that machines, gears, belts, and other moving parts are well guarded. In a factory where electrical apparatus is the principal product, danger of injury from shock must be guarded against, for in the different testing departments electric currents at high pressure are commonly used. The safety inspector must see that suitable protection against electric shocks is provided for.

Instruction in Accident Prevention

Each prospective employe of the General Electric Co., before being engaged, is subjected to a physical and medical examination to discover if he is afflicted with any contagious or infectious disease, or if he has any bodily weakness that would impair his facilities for doing his work. If such are discovered, he is given instructions as to proper treatment. On entering the employ of the company each employe receives a book in which are set forth instructions that, if followed, will safeguard him from most accidents. Incorporated therein is also a full description of the procedure for applying the prone method of resuscitation from electric shock.

But the instructive work does not stop after the employe has been engaged. From time to time lectures on safety are given to the foremen and general employes. These are suited to the particular classes of workmen to whom they are given; for instance, the foundrymen are given a lecture on the prevention of accidents in the foundry. One of these foundry classes is illustrated above. Other classes of employes are given talks in the same way. As shown in Fig. 1 demonstrations are frequently given to illustrate "first-aid" practice. A lecture room has been installed in which the foremen are given lectures, and at times halls are hired in the city of Pittsfield in which general lectures are given that are open to all employes of the company. For the benefit of the women employes of the plant, special lectures are given to emphasize the danger of catching the hair and clothing in moving parts of machinery. Treatment of cases of fainting and the method of employing the prone method of resuscitation from shocks are demonstrated from time to time.

The Company Hospital

An important feature of the work is the maintenance at the plant of a hospital with a graduate nurse and a steward in charge, where all accidents, even trivial ones, may be properly attended to. There is a men's department as shown in Fig. 4, and a woman's department as shown in Fig. 5, and all the modern surgical appliances are at hand for the treating of wounds. Besides the attention which is given to accidents, the nurse and steward will gladly consult with any of the employes in regard to medical or surgical treatment by outside physicians.

Ready for instant use is an automobile ambulance, as Fig. 2 shows, which can visit the scene of an accident at once and convey the patient to the emergency hospital or to the general surgical hospital of the city of Pittsfield if necessary. In the Pittsfield city hospital, the General Electric Co. also maintains a bed which is free to employes in case of sickness.

"Current News"—the Factory Newspaper

Not the least interesting of the methods by which the gospel of accident prevention is spread among the employes

* Associate Editor of MACHINERY.

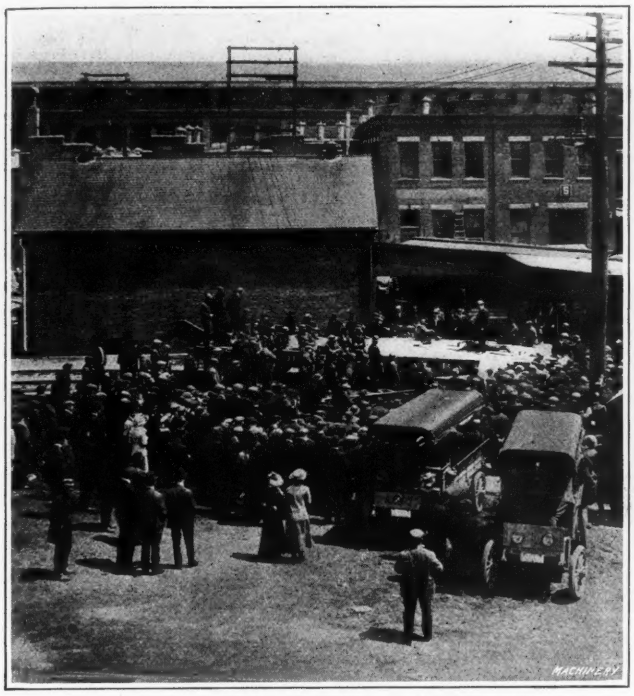


Fig. 1. First-aid Demonstrations are frequently given

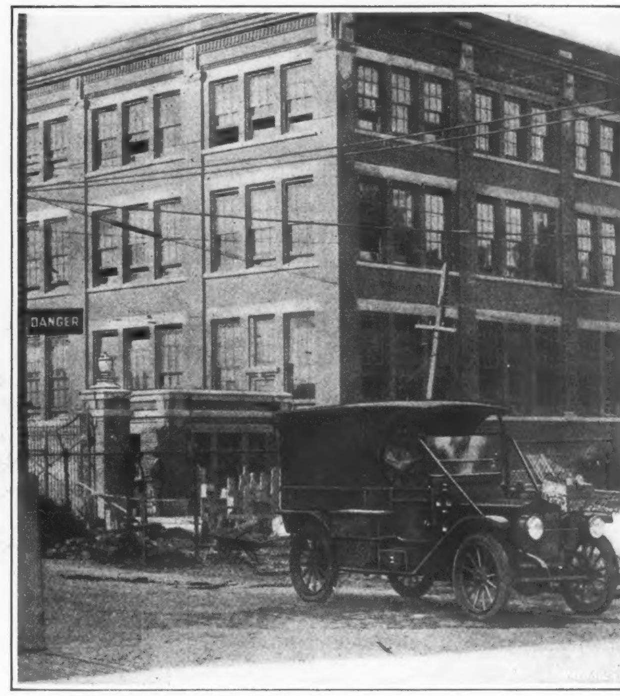


Fig. 2. The Hospital Ambulance is always ready for a Summons

of the plant is the little periodical called *Current News*. This is a monthly publication and about four thousand copies of each issue are printed and distributed gratis to the employes. The cost of getting out this publication is extremely low and it is distributed by being placed in a convenient location where the men may help themselves when leaving the factory after being paid off. Fig. 6 shows a copy of this paper in the hands of a workman leaving the factory. It is encouraging to note that very few copies are found scattered about after the men have left, showing that the paper is carried to the homes of the men in almost every instance. This is especially to be desired, as it then takes its place in the regular reading of the household and its effect is not spent on the employes alone, but on all others who pick it up and read it, and some of these may be future employes. This little paper has a great deal of the news of the factory, changes of work, notices of new employes and those leaving, and any items of interest connected with the factory work. Sprinkled freely throughout its columns are illustrations showing the safety measures that are being taken and especially is mention made of any accidents that have been prevented. An employe who saves one of his fellow-workmen from accident is publicly commended.

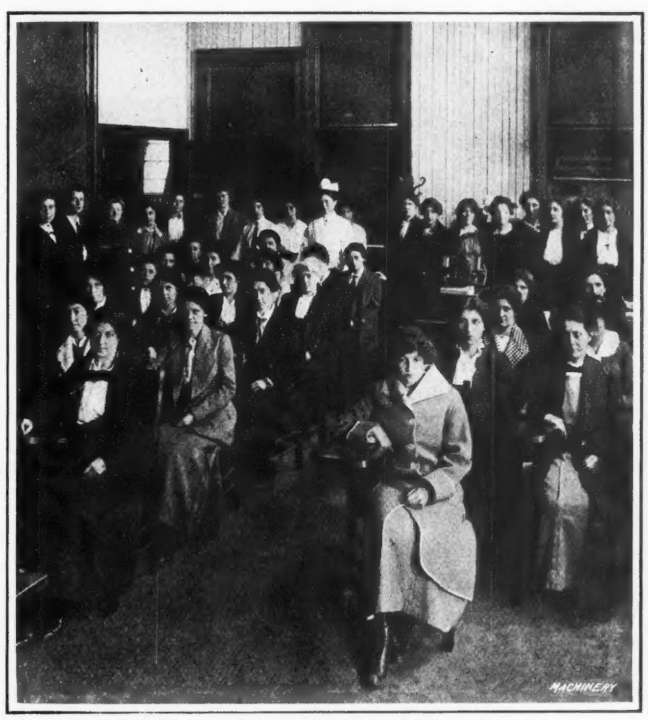


Fig. 3. Women Employes being instructed in Prone Pressure Method of Resuscitation

The Company's Restaurant

While not properly classed as a safety measure, the company maintains a restaurant at which the employes may get wholesome food at a low price. The restaurant is a model of cleanliness and in it is incorporated all of the latest culinary appliances such as electric

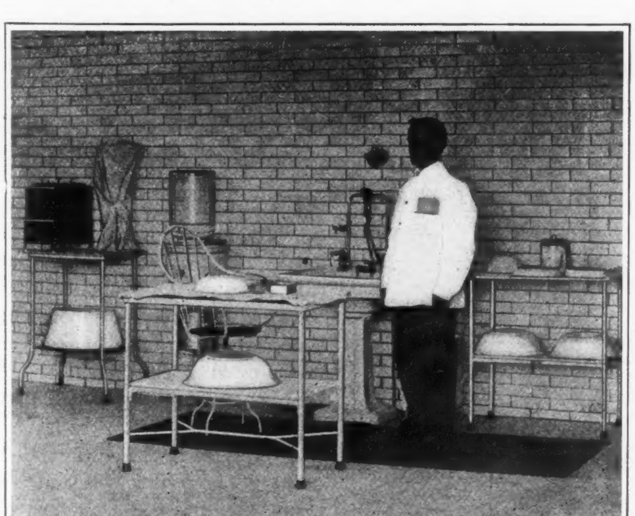


Fig. 4. A well equipped Hospital is maintained

Fig. 5. The Women Employes are cared for in a Special Ward

ranges, electric potato peelers, ice machines, food choppers, and dish-washing machinery. Unlike most other shop restaurants, this one furnishes breakfast and supper as well as dinner. A full course meal is served for twenty-five cents, and the office employes are taken care of at special tables. The best of good fellowship comes out at these noon-time gatherings, and it is a great improvement over the patronizing of the motley collection of restaurants which spring up around any large factory.

Classification of Accidents and Special Preventative Methods Employed

On taking up this work, the welfare department first secured the statistics of the past accidents of the company, and found that they readily classified themselves in importance into five distinct groups: First, and greatest in number, were the accidents due to electric shocks; second, the cases of foreign particles in the eyes; third, the foot-

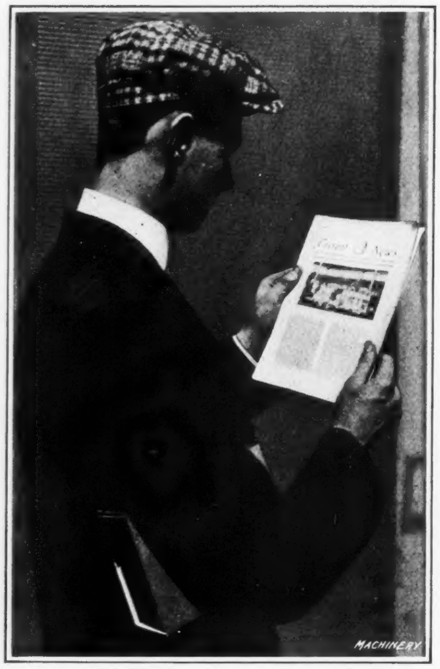


Fig. 6. Reading a Copy of "Current News"

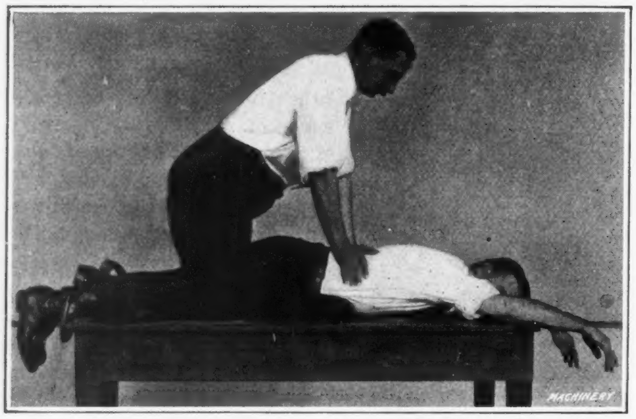


Fig. 7. Demonstrating the Prone Pressure Method of Resuscitation

Fig. 8. The Wearing of Goggles has saved many Eyes of Employes

burns of the foundry; fourth, the punch press accidents; and fifth, strains and ruptures. The welfare department took up these groups of accidents successively, and the corrective measures that were adopted to apply to the different groups are as follows:

Electric Shocks

To combat the cases of electric shocks, all employes are instructed in the rules of the National Electric Light Association for the resuscitation of life by the prone method. These instructions are supplemented from time to time by demonstrations to classes of the method of applying this treatment as shown in Fig. 7. For the benefit of the women employes, special demonstrations of the prone pressure method are conducted. Fig. 3 shows one of these classes. Articles are also published from time to time in *Current News* illustrating how to apply this method. It is gratifying to note that since 1913 not a single life has been lost by shock at this plant, and there are several cases in which employes after receiving shocks have been brought to life again.

Eye Accidents

The cases of foreign particles in the eyes have been largely prevented by the provision of goggles for use in the foundry, grinding, and other departments where eye accidents have been frequent. These goggles are worn by male and female operators alike, as shown in Fig. 8, and it is estimated that in the foundry alone at least one eye is saved a month by the wearing of goggles. Their use is made compulsory on dangerous work, and an employe refusing to wear them is discharged. In the last year there has not been a single case of losing an eye, and but very few cases where foreign bodies have done injury to the eye. The right-hand view in Fig. 8 also illustrates the head covering that is used by women operators to protect the hair from catching in belts or machinery.

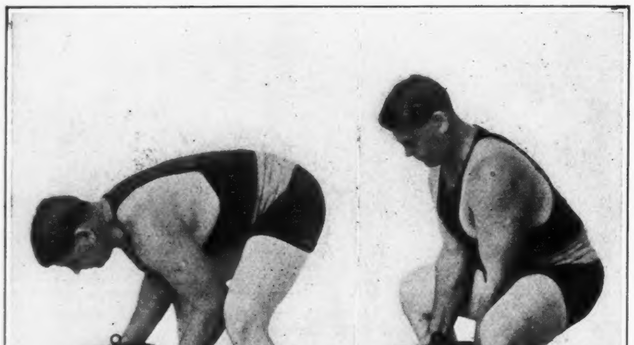


Fig. 9. Demonstrating the Wrong and Right Ways of lifting

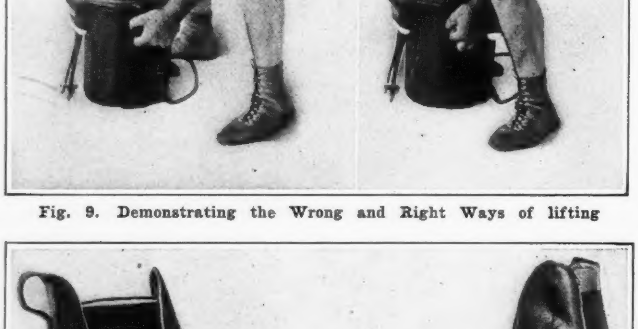
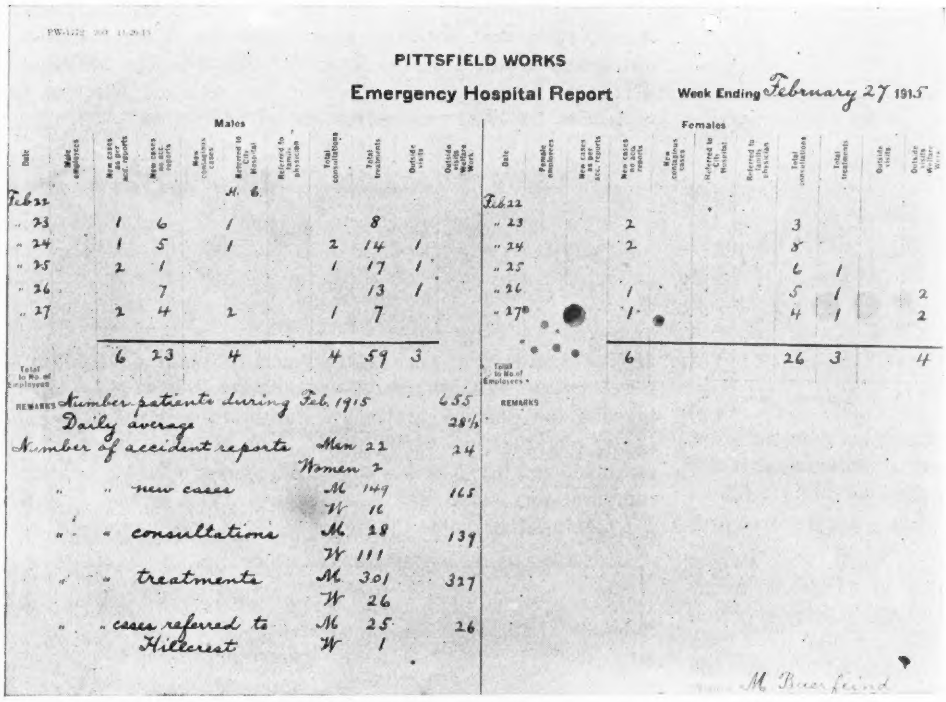


Fig. 10. "Congress" Shoes for preventing Foot-burns in the Foundry

Foundry Foot-burns

Trouble from foot-burns was formerly frequent, the employes of the foundry, of course, being the victims. Molten metal, leaking or running over from ladles came in contact with the workmen's feet, and bad burns were the result. This trouble has been almost entirely obviated by instructing the employes in the benefits of wearing "congress" shoes while at their work in the foundry. A pair of these shoes is shown in Fig. 10. Most of the foot-burns of the foundry seem to have been augmented by the catching of the molten metal upon the lacing of the ordinary shoe. A laced shoe is particularly hard to free from the foot rapidly, and the result is that the metal catching upon the shoe burns through before the metal or shoe can be taken off. In case the employe steps into or on molten metal it is impossible to get a laced shoe off quickly enough to prevent serious burning. The surface of a congress shoe over the instep is perfectly smooth, it being



PW-1172 ... 11-29-15

PITTSFIELD WORKS

Emergency Hospital Report   Week Ending February 27 1915

Males

Date	Male employees	New cases as per acc. reports	New cases no acc. reports	New contagious cases	Referred to City Hospital	Referred to family physician	Total consultations	Total treatments	Outside visits	Outside visits Welfare Work
Feb 22					H. 6					
" 23		1	6	1				8		
" 24		1	5	1			2	14	1	
" 25		2	1				1	17	1	
" 26			7					13	1	
" 27		2	4	2			1	7		
Total to No. of Employees		6	23	4			4	59	3	

Females

Date	Female employees	New cases as per acc. reports	New cases no acc. reports	New contagious cases	Referred to City Hospital	Referred to family physician	Total consultations	Total treatments	Outside visits	Outside visits Welfare Work
Feb 22										
" 23			2				3			
" 24			2				8			
" 25							6	1		
" 26			1				5	1		2
" 27			1				4	1		2
Total to No. of Employees			6				26	3		4

REMARKS Number patients during Feb. 1915 655
Daily average 28 1/2
Number of accident reports Men 22 24
Women 2
" " new cases M 149 165
W 16
" " consultations M 28 139
W 111
" " treatments M 301 327
W 26
" " cases referred to Hillcrest M 25 26
W 1

REMARKS

M. Buerfeind

Fig. 11. A Weekly Report of all Accidents is made by the Hospital

in the press department are continually cautioned against putting fingers under dies, and notices to this effect are conspicuously posted. Moreover, every punch press operator is provided with a pair of pliers like those in Fig. 15 before they were "caught" by the press, for a pair of fingers is worth more than the best pair of pliers made. Many of the presses are fitted with the Bliss non-repeating attachment to make doubly sure that the presses do not repeat and cause accidents.

Sprains and Ruptures

The injuries due to sprains and ruptures were found hardest of all to cope with. The activities have been directed along educational lines, giving frequent lectures to employes to show them the precautions to observe when lifting. At these lectures the services of physical instructors have been secured, and as illustrated in

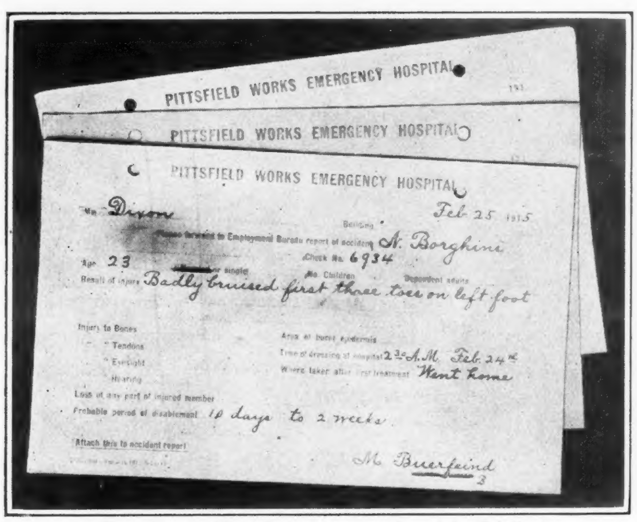


Fig. 12. Accident Reports are made out in Triplicate

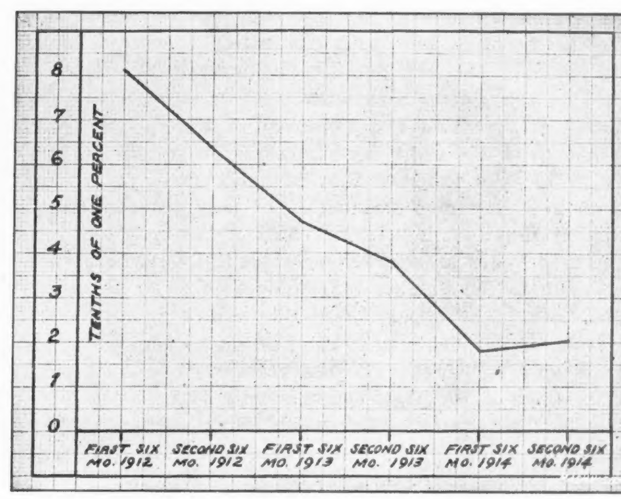


Fig. 13. The Accident Ratio Curve shows an almost Constant Drop for Three Years

held on the foot by elastic gores at the sides. Consequently, when molten metal strikes the surface of the shoe, it runs off, as nothing tends to make it cling. In case of stepping into molten metal, the shoe may be kicked off very quickly. By the use of congress shoes that may be quickly slipped on or off, these accidents have almost entirely ceased. During the three months previous to this writing, there was not one case of footburn.

Punch Press Accidents

The injuries to hands from punch presses are always a serious factor in the casualty list of a factory. These arise from one general source—the placing of fingers between punch and die. Contributory causes are the "repeating" of the press and the carelessness of the operator in tripping the press. To combat this class of accidents, the employes

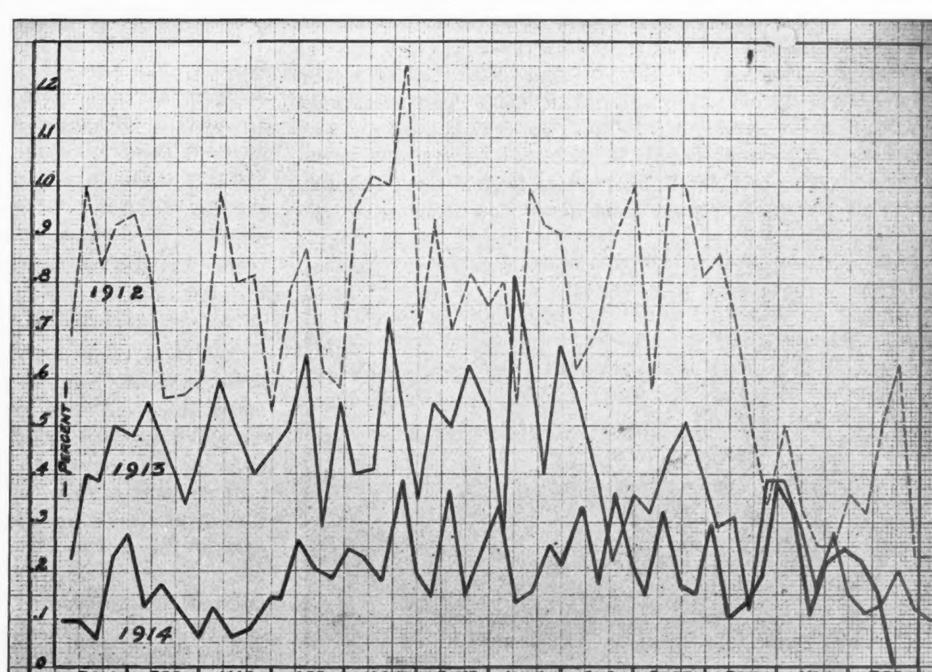


Fig. 14. A Chart of Three Years Accidents shows that Preventative Work pays

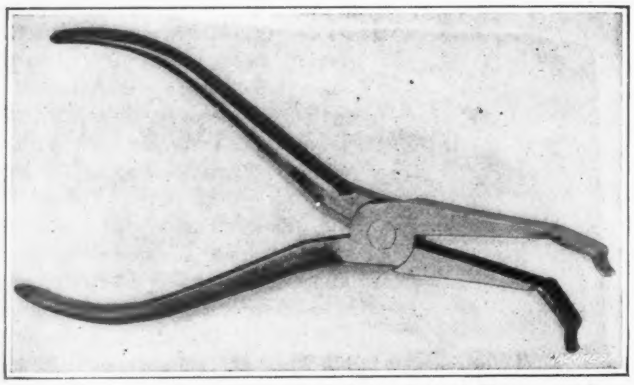


Fig. 15. A Pair of Pliers spoiled—but a Pair of Fingers saved

Fig. 9, the wrong and right ways of lifting are demonstrated. There is probably no more efficient way of impressing these precautions in lifting than by a demonstration of this kind.

Results of Accident Prevention Work

Since the inception of the preventative work, long strides have been made in reducing the number of accidents at the Pittsfield works. The general safety committee has gotten out rules and regulations for crane operators that have been standardized and adopted by other factories. From the records of accidents that have been kept, many interesting points have been brought out.

Every accident is reported in triplicate, and facsimile reports are shown in Fig. 12. One copy of this report is filed with the hospital, one with the safety inspector, and the third goes to the employment department where it is reported to the state. Also each week a summarized report, a facsimile of which is reproduced in Fig. 11, is compiled and filed with the same departments. From these data it is easy to see the progress that is being made in the work, and to note any new accidents that may have taken place.

Fig. 14 shows an interesting chart of the accidents for the past three years at the Pittsfield plant. This is plotted in proportion to the number of employes in order to allow for fluctuations. The upper dotted line shows the curve resulting from the accidents in 1912. The 1913 curve below shows a considerable decrease in the percentage, and the lowest curve, which is for 1914, shows a still better average. Fig. 13 shows the average of the ratios of all accidents for three years, and it is gratifying to note that the curve represents an almost constant decrease.

An interesting diagram is the one shown in Fig. 16 in which has been charted the combined accidents for a certain period and the hours between which they occurred. From this it will be seen that by far the greater number of accidents occur in the morning between the hours of 8 and 11. The reason advanced for this is that during this period the men have become fatigued during their long morning's work, and there is a rush to get work completed by the noon hour. The combination of this fatigue and the extra pressure exerted to get things accomplished is no doubt responsible for the increased accidents at this time.

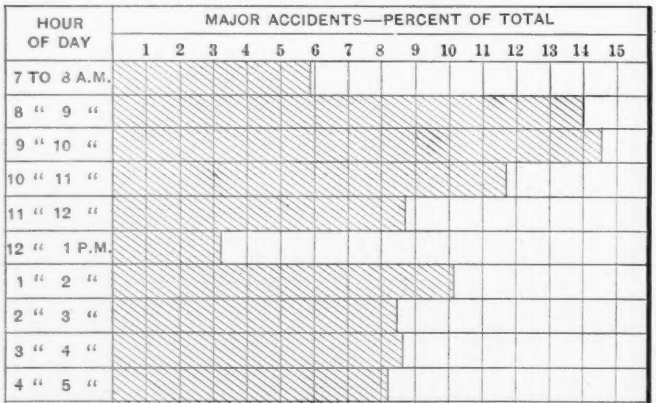


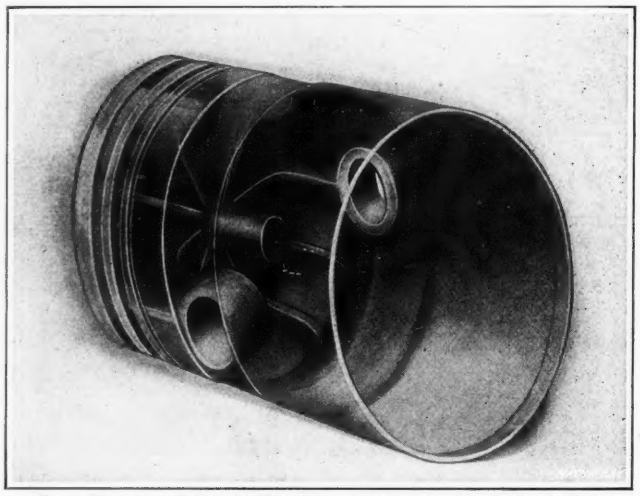
Fig. 16. The Greatest Number of Accidents occur between 8 and 11 A. M.

If the evidence of the past three years forms a criterion, it is certain that within a short time the safety inspectors, nurse and steward of the hospital, and even the ambulance driver at the Pittsfield plant of the General Electric Co. will have "worked themselves out of their jobs."

* * *

LEVETT MAGNALITE PISTONS

The accompanying illustration made from an "X-ray drawing" shows the internal reinforcing ribs of the magnalite pistons made by the Walker M. Levett Co., 10th Ave. and 36th St., New York City. Magnalite is a special aluminum alloy having a thermal conductivity several times that of cast iron, and a specific gravity slightly less than that of aluminum. Light weight pistons of high thermal conductivity are advantageous for modern high-speed internal combustion motors. Light reciprocating parts permit high rotative speeds to be attained, making possible the development of great power in comparatively small and light motors. The system of internal ribbing distributes the metal to the best advantage and increases the thermal conductivity so that danger of the alloy melting at the high temperatures obtained in gas engine cylinders is practically eliminated.



X-ray Drawing of Levett Magnalite Piston, showing Internal Ribs

* * *

WIRELESS TELEPHONY RECORD

A remarkable achievement in wireless telephony was accomplished September 30 when the human voice was transmitted from Washington to California, a distance of 2500 miles without wires. The message was transmitted from New York to Arlington, Va. by wire and thence to Mare Island, Cal. through the air. The following day conversation was held by wireless from the Atlantic seaboard to Hawaii, a distance of 4600 miles. The engineers of the American Telephone & Telegraph Co. and the Western Electric Co. have been working on the problem of wireless telephony for years. The success achieved probably insures the establishment of transatlantic wireless communication when the disturbed conditions in Europe are settled.

* * *

DAILY COMMERCE REPORTS

The Department of Commerce, Washington, D. C., has for some months been publishing a daily journal called *Commerce Reports*. E. E. Pratt, Chief of Bureau, has sent out a circular letter calling attention to the value of this publication to sales managers. He states that American business men cannot afford to overlook a publication which secures information from three hundred consular officials located in every part of the world. The publication contains special articles prepared by commercial attachés and agents of the Department of Commerce, stationed at the most important centers of foreign trade. Lists of firms in foreign countries anxious to buy American goods and represent American manufacturers are published daily. The subscription price of *Commerce Reports* is $2.50 a year.

OXY-ACETYLENE WELDING PRACTICE*

WELDING OF MALLEABLE IRON AND COPPER AND COPPER ALLOYS

BY S. W. MILLER†

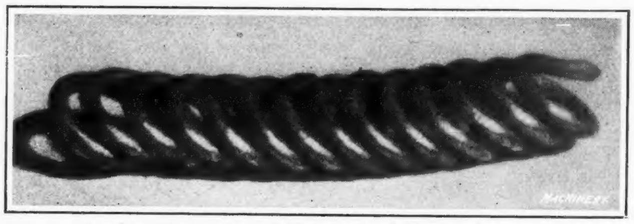


Fig. 1. Graphic Illustration of Movement of Torch when welding Steel

THE melting point of ordinary machine steel is about 2650 degrees F., that of wrought iron about 2740 degrees F., while that of cast iron varies, depending on the composition, from 2000 to 2200 degrees F. Hence, the welding of wrought iron and steel presents a problem entirely different from that involved in the welding of cast iron.

Metallurgy of Iron and Its Relation to Welding

Iron is one of the chemical elements, existing in large quantities in nature in the form of ores. These ores are reduced by various processes and from them is produced, first, pig iron. In the production of ordinary castings, the pig iron is remelted and mixed with scrap castings and other materials, to produce what the foundryman desires. The metal, however, retains all the characteristics of pig iron, except that its constituents vary in quantity. All cast iron consists of pure iron mixed with different proportions of carbon, silicon, manganese, sulphur and phosphorus. There are other elements, but they exist in such small amounts and have such a slight effect on the quality of the metal that they need not be considered here. None of them requires serious consideration except carbon, silicon, sulphur, phosphorus, and manganese. These elements may be valuable or not, depending on conditions, but sulphur and phosphorus are always injurious in ordinary iron, and their percentage is kept as low as possible. They do not generally bother the welder, and therefore need not be further considered.

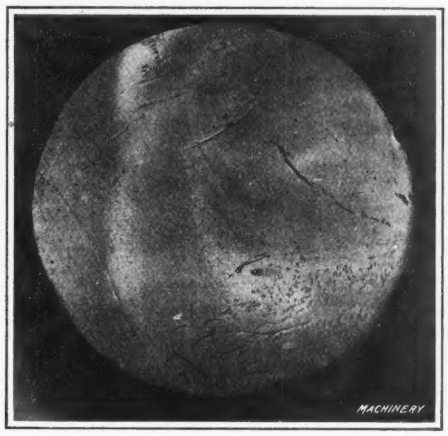


Fig. 2. Section of Defective Weld in Steel Bar

Carbon exists in pig iron, or ordinary cast iron, in two conditions, which are called "combined" carbon, and "free" or "graphitic" carbon. The combined carbon exists as carbide of iron, or in other words, it is alloyed with the iron forming a definite chemical compound. Graphitic carbon exists in the free state as graphite, and can be noticed in very soft pig iron, as it will blacken the fingers or make a mark on white paper. Cast iron contains a total amount of carbon varying from about 2½ to 4½ per cent. The percentage of graphitic carbon in a cast iron having a given total amount of carbon, varies in accordance with the size of the casting and the rapidity with which it is cooled. Slow cooling of a large casting increases the percentage of graphitic carbon, while the total amount of carbon remains the same. This graphitic carbon exists in the iron in the shape of plates between the grains, and it is evident that the larger these plates are, the weaker the iron. It is well known that large castings have less tensile strength per square inch than small castings poured from the same ladle.

There is a variety of cast iron known as "white" iron which contains no graphitic carbon. It is sometimes called "chilled" iron, because when iron is cast against a steel or iron chill plate, or other cold surface, it cools quickly and the quality of intense hardness which is desirable in certain castings is obtained. It is called white iron on account of its silvery appearance when broken. Iron suitable for chilling has a smaller percentage of silicon and a larger percentage of manganese than ordinary cast iron, because silicon has the property of preventing carbon from combining with iron, while manganese has exactly the opposite effect. It might be stated here that this is the reason why ordinary cast iron is unsuitable for welding rods. Ordinary castings do not require a high percentage of silicon, and a reasonable amount of manganese is not objectionable but is of some advantage at times in making the iron close-grained and strong and in counteracting the bad effects of sulphur. Therefore, welding rods are made from iron which is high in silicon and low in manganese, so the metal in the weld may be soft and readily machined.

On account of the size of the grains in a cast-iron fracture, it is well known to everyone handling it that it is crystalline. A magnifying glass will readily disclose this fact. It is not, however, so well known, and indeed not so well as it should be, that steel is equally as crystalline as cast iron; for instance, a piece of hardened tool steel does not appear to be so, and in the case of some high-speed steels, the fracture appears almost amorphous. It is very common to hear the expression, "that piece of steel broke because it was crystallized." It is still less commonly known, and indeed many metal workers do not believe, that wrought iron is of crystalline structure, but it is a fact. This is very readily seen by comparatively low power magnification under a microscope, of a properly prepared specimen. Every blacksmith knows that a piece of wrought iron nicked and broken across the anvil will show a more or less crystalline fracture, although it is frequently attributed to defective material or sudden shock, or some other more or less obscure cause.

Difference between Cast Iron, Wrought Iron and Steel

The essential difference between cast iron, wrought iron and steel is the percentage of carbon contained in them. As before stated, cast iron varies from 2½ to 4½ per cent, while steel contains from 0.05 to 2 per cent, wrought iron containing 0.05 per cent, or less. The essential difference between steel and wrought iron, using the terms in their commercial sense, is simply in the method of manufacture. Wrought iron is made by puddling cast iron in a reverberatory furnace until the carbon is burned out of it. The resulting pasty mass, which is full of slag, is then squeezed in a heavy press which forces the slag out of it, as it is more liquid than the iron. It is then reheated, passed through sets of rolls, and if a better quality is desired, cut in short lengths, piled together, heated and again rolled. However, it is impossible by this process to remove all the slag, and this can be detected with a magnifying glass, and frequently seen by the naked eye in a bar of wrought iron. This slag tends to weaken the iron, not only because it has no tensile strength itself, but because it prevents the grains from coming into intimate contact.

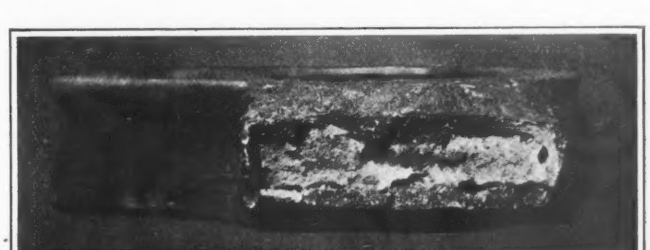


Fig. 3. Malleable Iron improperly welded

* For material on oxy-acetylene welding previously published in MACHINERY, see "Oxy-acetylene Welding and Cutting Equipment," "Preparation of the Work for Oxy-acetylene Welding," and "Practice of the Oxy-acetylene Welding Process," in the October, 1915, number.

† Address: Rochester Welding Works, Rochester, N. Y.

Steel is produced by melting cast iron, either in a Bessemer or open-hearth furnace for ordinary material, or, in the case of high quality materials for tools, etc., in crucibles. A Bessemer furnace operates by burning out the carbon entirely, leaving a mass of melted iron. The necessary amount of carbon is added by the use of ferro-manganese or other high-carbon material, and the steel poured into ingots which are rolled down to the various shapes and sizes desired. The open-hearth furnace is different from the Bessemer in that there is no air blast used to burn out the carbon and that a better mixture can be obtained, because the process is slower and under better control. It produces a better and more uniform grade of steel than the Bessemer furnace, and is universally used at the present time where the best quality is desired.

It is evident that the melting process eliminates nearly all possibility of slag in the metal. Slag is lighter than melted iron and tends to rise to the surface of the liquid mass, while in the puddling process the stirring up of the iron oxidizes part of it and mixes it with the body of the metal from which it cannot escape.

A crucible is in reality a small open-hearth furnace, and its use, as has been stated, is confined to tool steel which requires careful control of the carbon and other elements in it, small quantities of which materially affect the composition and action in service. It is also necessary to have great uniformity in the product which can be best obtained by handling small quantities of it at a time.

Welding of Steel

The steels which the welder will meet most frequently contain from 0.20 to 0.45 per cent carbon, and are called ordinary low-carbon steels, that is, they do not have any elements in them, such as chromium, vanadium, tungsten, nickel, etc., which have in the last few years been alloyed with ordinary steel to obtain very high tensile strength and elastic limit, and which are mostly used in automobile construction so as to obtain maximum strength and service with the least possible weight.

The carbon in ordinary carbon steels varies with the uses to which they are put. For instance, boiler sheets will run about 0.18 per cent, spring steel about 1 per cent, steel for railroad axles about 0.40 per cent. There are many varieties of steel having carbon between these points; it will be found in practice that the steels with the least carbon weld most easily and give the best results. The reason for this is that when steel is melted, as in the welding process, the carbon is more or less burned out of it, and unless great care is taken, the steel will be burnt. The greater the amount of carbon, the greater the danger. Steel may be overheated without burning, but if it is once burnt, it cannot be restored except by remelting it.

Burning of Steel

Some explanation in regard to the burning of steel may be of assistance in making clearer some things that the welder will encounter, and help him to avoid trouble. As stated, steel is composed of crystalline grains, which are smaller or larger according to the process of manufacture. These grains are separated from each other by thin membranes which vary in composition, their thickness and nature depending on the percentage of carbon, and the heat-treatment and working to which the steel has been subjected. During the process of melting steel with the torch, the metal is subjected to a very high temperature. If this temperature is high enough, and the steel is left in contact with the heat long enough, it has been found that atmospheric oxygen finds its way between the grains and combines with some of the carbon, forming carbon monoxide, forcing the grains apart, and making the metal brittle. This action is intensified by the film of oxide formed by the action of the oxygen. This makes it impossible to restore the steel by heating to a lower point and forging it, as the grains will not again cohere. In other words, burning is a mechanical separation of the crystalline grains.

The welding rod ordinarily used for welding steel contains very little carbon, being generally made of Norway iron. Inasmuch as the less the carbon the less the chance of burning, the metal added in welding is not burnt if ordinary care is used, but if the parts welded are of high-carbon steel, the metal next to the weld is damaged, with the result that while the weld itself remains intact, the piece breaks next to the weld. It is impossible to burn wrought iron, as it has practically no carbon. Another thing that should be realized is that while wrought iron, which has practically no carbon, melts at about 2750 degrees F., the melting temperature of steel decreases as the percentage of carbon increases, and steel with $1\frac{1}{2}$ per cent carbon melts at about 2300 degrees F. Not only is this true, but it is also a fact that the more carbon the steel contains, the longer time it takes to solidify after melting, the same as cast iron does, while wrought iron solidifies almost instantly. These two things, the lowering of the melting point and the length of time the metal stays melted, make high-carbon steel particularly susceptible to burning. It is therefore practically impossible to weld high-carbon steel, at least steel containing over 1 per cent carbon, and the larger the section, the more difficult the work is, as it has to be kept under the influence of a high temperature for a longer time.

What has been said does not refer to steel that has simply been overheated. This condition is brought about by heating to a very high temperature, but not above the melting point. Such steel can be restored, at least to a certain degree, by heat-treatment, and will also be helped by forging, if this is possible. It is frequently claimed that burnt steel can be restored by the use of a flux or by various methods of treatment. It is evident from the explanation given that this is not possible, and that where so-called "burnt" steel has been restored, it has not really been burnt but simply overheated.

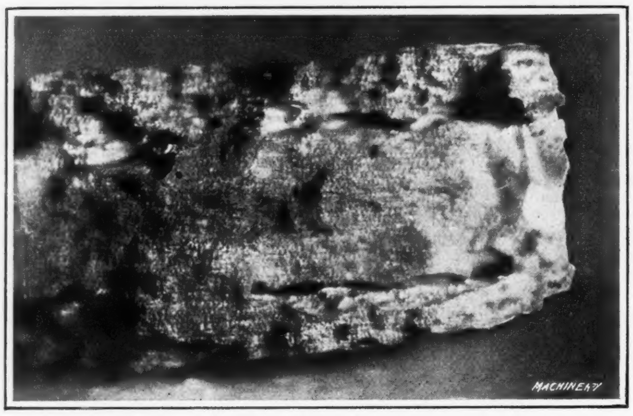


Fig. 4. One End of Piece in Fig. 3 magnified

Methods for Welding Steel

The methods used in welding steel are somewhat different from those followed in the case of cast iron. The ordinary steels handled by the welder solidify quickly; there is therefore a greater danger of the metal not being thoroughly united at all points, resulting in cold-shuts. The welding wire is more likely to be burnt on account of its comparatively small section. Therefore, it is necessary that the method of handling the torch and welding rod suit these conditions. It is possible in the case of cast iron at times to use a V with an angle of less than 90 degrees; in fact, it is sometimes advisable to do so. In the case of steel, however, unless it is less than $\frac{1}{8}$ inch thick, the 90-degree angle must be maintained, or the bottom of the weld will not be sound or will consist of a series of cold-shuts and laps. Again, if the torch is used to widen the V, a series of craters, so to speak, is likely to be formed, which are exceedingly difficult to eliminate. These craters are caused by the metal in the center being colder than the metal around the edges, due to the conduction of the heat away from the bottom of the crater, or to the fact that it is not possible to get the point of the flame far enough into the hole to melt it. The only way to avoid them is to move the torch, giving the tip a circular motion around the hole, until the surrounding metal is brought to a temperature sufficiently high to prevent the conduction of

heat, when a sudden lifting of the torch will allow the metal to flow together. This circular motion of the torch has been found to be the most satisfactory way to weld steel. It is very difficult to describe, but once seen it is easy to understand. The author knows of nothing that it resembles so much as a helical spring crushed down sideways as shown in Fig. 1, the torch tip following the path of the spring wire, advancing a little, as from coil to coil, at each revolution. The speed of rotation and advance have to be made to suit the work. Of course, in heavy welds this cannot be done, as metal is added. In this case the wire should be used as a sort of a center around which the torch is oscillated, the path being somewhat more than a half circle. In this case the wire should never be removed from the pool of melted steel, as the tendency is then to burn it. The flame should not be turned directly against the welding wire, but kept far enough away from it so that while the wire is melted, the flame does not touch it; and the flame should not be kept on the metal any longer than is absolutely necessary.

Steel does not form a comparatively large melted pool as in the case of cast iron, and, therefore, it is necessary to be careful about welding the edges. As soon as the metal is brought to the melting point, if the torch be raised suddenly, the metal which has been blown into a shallow cup shape by the force of the blast, will at once become level and solidify. Hence a good steel welder keeps his torch constantly in motion, using the rotary movement and quick elevation.

From what has been said of the danger of burning steel, it is evident that it is important to use the right size of tip,

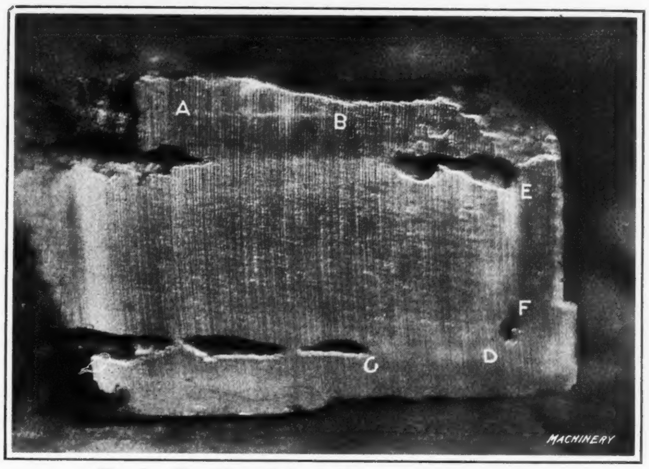


Fig. 5. The Other End of Piece in Fig. 3 magnified

neither too large nor too small, and also to provide sufficient sizes of wire to prevent the burning to which it is liable. The author finds that three sizes are sufficient for the majority of the work of an ordinary welding shop—1/16, 1/8, and 3/16 inch.

It is evident that on account of the affinity of iron for oxygen at a high temperature, the flame should be neutral, and not only this, but there should be no oxygen escaping from the torch where it can combine with the melted metal. This is particularly important in the case of steel. The writer knows of instances where it was impossible with a certain type of torch to produce satisfactory welds, while another, which used less oxygen, gave entirely satisfactory results. This emphasizes the importance of good apparatus.

It should be remembered that the weld is only a casting, and that it has received no forging or other treatment to refine the grain and to make the metal stronger. In a few cases an extra amount of metal can be added to the weld and the piece drawn out with a hammer, or otherwise worked to produce a stronger metal, but this cannot generally be done where the dimensions of a piece must be maintained. It is possible, however, by heat-treatment, to increase the tensile strength and elastic limit of the metal to a certain extent.

Heat-treatment of Welded Steel

In the case of a small piece, allow the steel to cool down after being welded until the color disappears. It can then be again heated with the torch, testing it with a magnet until the magnet is not attracted. It can then be allowed to cool. It has been found that this treatment makes the metal tougher. In the case of a large piece, if it is not too expensive, it can be heated with a torch, or otherwise in a forge to a temperature at which it will not attract a magnet. The important thing is to have the temperature uniform throughout, and allow it to cool uniformly. The larger the piece, the less the rapidity with which it will cool when exposed to the air. Small pieces should be protected during cooling, while large pieces may be allowed to cool in the open.

Another treatment which is of advantage at times, but which is difficult to apply to a small piece, is what is known as the "Coffin toughening process." In consists in heating the steel just above the recalescence point, or to the temperature where it will not attract a magnet, plunging it into cold water in a dark place, until the red color just disappears, when it is removed and allowed to cool in the air. It will be noted that this is approximately the same as the ordinary hardening and tempering process, but for toughening purposes it should never be applied to anything but comparatively low-carbon steels. It produces an intensely tough structure, and if properly carried out, gives very good results, although the best results are only obtained if the metal is forged before heat-treating.

The heat-treatment of alloy steels is quite a complicated process, and can only be carried out with the proper apparatus. No welding shop with which the writer is acquainted has any facilities for doing this work, and as the ordinary welding rod does not have the necessary ingredients to make a truly homogeneous weld, and as at the best the weld is only a casting, the welding of alloy steels should be avoided. It is true that in special cases and where there is a knowledge of the character of the metal, fair results may be obtained, but this information is not possessed by the average welding shop doing repair work, and it is best to restrict the welding operation to materials which it is known can be welded successfully, because no good comes from attempting work beyond the limitations of the process.

General Considerations

It would appear perfectly feasible to use welding as a process for joining steel parts wherever riveting is now employed. In many cases it is possible to do so, but in many other cases it is not advisable. While a riveted joint is imperfect in many respects, and a poor mechanical construction, yet its strength and the practices followed in making it are so well known, that the riveted joint is certain to remain. The lack of knowledge of the technique of welding, the scarcity of competent welders, and the prices of the gases, often make the cost of welding prohibitive and the quality of the work uncertain, when an attempt to replace a riveted joint is made. The time will come when large structural work will be done by the oxy-acetylene process, but the time has not yet arrived when it can be relied upon as well as present methods. However, the welding of steel by this process is being extended every day, and things are done now which were not dreamed of a few years ago. Therefore the further extension of the possibilities may be reasonably expected.

Many of the defects which occur in a cast-iron weld are likely to occur in a steel weld, some of them being more frequent and more difficult to avoid. The most serious is a lap of the hot metal on top of the cold; this is an exceedingly common defect with new welders. It is much more likely to occur in a large piece than in a small one; in fact, the larger the piece of steel, the more difficult it is to make a sound weld. The difficulty is caused either by the addition of too much steel at once, so that it flows over onto the metal underneath without being welded to it; by dropping the metal from the welding wire onto the metal underneath, instead of keeping the end of the wire in the pool of melted metal; or by carelessness in not thoroughly welding the edges of the melted pool to the rest of the metal. The metal is far more likely to bridge in the case of steel than in the case of cast iron, particularly where the pieces are V'd from both sides, when the weld is started at the bottom of the second V after turning the piece over.

Fig. 2 shows an enlarged view of a defective weld, the original piece being 1½ inch in diameter. A large number of laps and cold-shuts will be distinctly noticed. The polishing to which this piece was subjected has brought out the difference between the original metal and the added material, and it appears clearly that the weld was imperfectly made, because this added material shows on four sides. In making a steel weld, the edges of the weld should be built out somewhat beyond the sides of the original pieces, so that it will not be necessary to burn down any on the sides to eliminate imperfect work. The weld should be so made that any roughness left on it when ground off will leave sound metal all the way around. There is always great danger of laps or cold-shuts when any other course is followed. This is particularly applicable to round pieces, which are more difficult to weld than rectangular ones.

Welding Malleable Iron

Those who have tried to weld malleable iron know that the results are usually unsatisfactory. The metal either becomes so hard that it cannot be machined, or it is brittle, or both. The reasons for this lie in the nature of the metal, which is not generally understood, because of the comparative lack of knowledge of its method of manufacture. To explain sufficiently for the present purpose why these difficulties exist and how they may be overcome, it is necessary to consider somewhat the metallurgy of cast iron and the changes which take place during its conversion into malleable iron.

It is necessary in making malleable iron to use white-iron castings, because graphite, being an inert substance and not acted on by the malleablizing process, cannot have its condition changed by this process, so that the carbon in iron from which malleable castings are to be made must all be in the "combined" condition, and not "free," as in gray-iron castings. Cast iron has a larger percentage of carbon than steel, and it would appear that if enough of the carbon could be removed from cast iron, so that it had about as much as ordinary steel, a product resembling steel, if not identical with it, would be the result. This was the aim of the inventor of malleable iron, Reaumur, and the process was carried out by packing the white cast-iron pieces in decarbonizing matter, such as oxide of iron, and subjecting the pieces so packed to a high temperature for a long enough time to reduce the percentage of carbon to the desired point. It was found that the time required to carry the action entirely through a piece was considerable, and therefore the cost was excessive; so that only thin pieces are now subjected to this process. Inasmuch as it was desirable to treat heavier pieces, it was found by experiment that it was not necessary to reduce the percentage of carbon all the way through the piece, but that by proper treatment in the annealing oven, the carbon could be changed into a third form to which has been given the name "temper" carbon, to distinguish it from "combined" and "free" carbon, although temper carbon is identical with graphite as far as can be determined. The first kind of malleable iron can generally be welded with steel, as it is really a crude steel. The second form, however, is the one that presents the difficulties spoken of above, and it will now be evident why these difficulties exist. Cast iron, when changed into steel, cannot, by melting under the torch, be changed into cast iron again; but in the second kind of malleable iron, the carbon is not removed, but only changed into another form. Therefore when melted, all the conditions are favorable to the reformation of chilled iron, which is exactly what occurs; so that the resulting weld is, as previously stated, hard and brittle.

Malleable iron can be welded with cast iron and a sound weld obtained, but it is not homogeneous. In some cases it may be entirely satisfactory; for instance, where special strength is not required, or where no finishing, except by grinding, is to be done. For all ordinary work, it has been found that the use of manganese bronze as a welding rod with a little borax used as a flux will make a weld, which, while not homogeneous, will answer the purpose. The precautions to be observed are as follows:

1. Malleable iron must not be melted, but only brought to a temperature at which the bronze will alloy with it. This is somewhat above a good red heat, and is easily ascertained by a few trials. A neutral flame must be used, and it is generally wise to add surplus metal to the weld.

2. It is a good thing for the welder to observe the action of the second kind of malleable iron under the torch. It will be noticed in a fresh break that the outside shell, say 1/32 inch deep, is white, and under the torch acts like steel, but the further in toward the center the flame is used, the more will the action appear like that of cast iron, and it will be found that steel cannot be used in welding. The metal also tends to become full of blow-holes. If the torch is used to melt such a piece, and it is then allowed to cool off and the surface ground and polished, it will be found to consist of white iron, except the thin outside shell. If a weld is made using a malleable iron welding rod, it will be found that the weld is very brittle, and when broken, will show the characteristic appearance of white iron. Of course such a weld may be made into malleable iron by putting it through the regular process, but this is not possible in repair work, although it is in certain manufacturing processes. Therefore the use of bronze appears to be the only present solution of the difficulty, and it would seem that the metallurgy of malleable iron makes impossible any other solution.

Figs. 3, 4, and 5 are good illustrations of the structure of malleable iron and of the damage done to it by improper welding. Fig. 3 shows the section nearly full size, while the others are enlarged to show the defects more clearly. There is considerable difference in appearance between the outside and inside of the piece. The piece was originally welded with steel. The second break occurred outside the weld, because the added steel at the first weld was considerable in amount, and therefore stronger than the section shown.

In Fig. 5, the difference between the center and the outside of malleable iron is very clear, the outside being darker and of steel, while the inside is of cast iron, but with the carbon changed to the "temper" form. Wherever the added steel is welded to the steel casing, the metal at the junction of the cast iron and steel has been seriously damaged, causing holes; and where there is no added steel, or where the weld between the two steels has been defective, as from *A* to *B*, no apparent damage has occurred. An examination of the piece shows that no extra metal was added from *C* to *D* or from *E* to *F*, and that on account of the defective weld between the two steels at *A* and *B*, no apparent damage is done to the metal below.

In repairing the break, it was found impossible to cut the defective pieces out with a hacksaw, as hard spots were encountered as soon as the added steel was cut through. It was therefore necessary to grind the defective parts away. This left a space which had to be filled up, which was done with manganese bronze, the weld being made and heavily reinforced with the same metal. The hard spots were caused by the malleable iron changing back to white or chilled iron under the high heat used.

Welding Copper and Copper Alloys

Under this heading will be treated the welding of pure copper and also the various kinds of brass and bronze which are made with copper as the principal ingredient. Copper is not a difficult metal to weld, if precautions are observed to avoid several peculiarities in its action when under a high temperature. It has the property, when melted, of absorbing gases to a very considerable extent. On cooling, these gases are given out and make the weld porous. Copper also oxidizes readily when melted and this oxide alloys with the copper, making it brittle and spoiling the weld. There is also a tendency, as in the case of steel, for oxide to form between the grains and make the copper weak. Inasmuch as copper cannot be welded by hammer blows or by pressure, it is impossible to work this oxide out, and methods must be used during the welding to eliminate it, or preferably, to avoid it altogether.

It has been known for a long time that a small percentage of phosphorus added to copper or copper alloys eliminates blow-holes and makes a sound, dense casting; hence, the

welding rod for copper should contain the proper percentage of phosphorus. Traces of phosphorus do not injure copper, but an excess is not good, so proper care and accurate knowledge are necessary to produce the proper welding material. Copper has great heat-conducting power—more so than any of the other common metals. It is therefore necessary to use a larger tip than for iron and steel, and preheating of the parts is more necessary in order to reduce the gas consumption, than in the case of other metals. On account of the affinity of copper for oxygen, and on account of the fact that an excess acetylene flame produces blow-holes in the weld, even with good welding material, it is necessary to use a neutral flame, although it will be found that instructions are sometimes given to the contrary.

Another peculiarity of copper is its brittleness at a temperature somewhat above a dull red, while below this temperature it can be readily forged. The welder must therefore be careful to look out for contraction strains as the metal is cooling down. Full and uniform preheating will help to avoid this difficulty. It is not often, however, that a repair welding shop is called on to work with copper, and when it is, the work is generally the simple welding of rods or bars together. In such cases enough metal should be added to make a considerable "swell" around the weld, and after heating to a dull red it should be forged. Care should be taken not to heat it too hot, and after the forging is done, the work should be allowed to cool off slowly, unless it has to be bent, when the whole piece should be heated to a dull red and annealed by plunging it in water, this operation being repeated frequently if the piece requires much working, as the working of the metal causes it to become brittle.

Copper Alloys

Copper alloys are divided into two general classes, brasses and bronzes. The principal ingredients in the former are copper and zinc, and in the latter, copper and tin. There are a great number of these alloys differing materially in composition, and as the welder cannot know the exact composition of each, and as, even if he did, it would be impossible to make the proper mixture to produce a truly homogeneous weld, a welding material should be kept in stock that will cover all of the cases with which he meets. It is the general experience that manganese bronze or tobin bronze is very satisfactory for all brasses and bronzes. It is the practice in the author's shops to use manganese bronze, as he has found that if more than one welding material is used for brasses and bronzes, it is difficult to keep them separated, their appearance being so similar, and that the slight practical difference in results obtained from different materials does not warrant their use.

In welding brass, when the metal is brought to a certain temperature by the torch, white fumes suddenly disengage themselves, and in the case of a large piece, these will chill and condense on the cooler surfaces. This is due to the volatilization of the zinc, the fumes being white zinc-oxide. The proper point at which to add the metal is just as the surface of the piece begins to boil and bubble, and as manganese bronze contains a large percentage of zinc, any zinc that may be lost in heating will be replaced by the metal in the welding rod. In the case of bronze, the zinc loss does not occur, but the bubbling of the surface of the heated piece occurs and determines the temperature at which the metal should be added. Manganese bronze is quite fluid and flows well, uniting nicely with the broken parts. It is advisable to use a small amount of borax as a flux to clean the surface, although no more than necessary should be used.

A neutral flame is the proper one to use for both brass and bronze. These metals are both good heat conductors, although not as good as copper. Generally the same size tip as for cast iron will be satisfactory. Care should be taken to avoid laps or cold-shuts in a weld, which is readily done if the metal is kept at the proper temperature. These metals are generally easy to weld, and as manganese bronze is exceedingly strong, the weld is generally the strongest part of the piece.

INTERNATIONAL ENGINEERING CONGRESS

The International Engineering Congress, held in the Auditorium Bldg., San Francisco, September 20-25, inclusive, was opened with an address of welcome by the mayor, followed by addresses by General Goethals and distinguished delegates. The John Fritz medal was presented to Dr. James Douglas, past president of the American Institute of Mining Engineers. The program comprised sessions on the Panama Canal, waterways, irrigation, municipal engineering, railway engineering, materials of engineering construction, mechanical engineering, electrical engineering, mining engineering, metallurgy, naval architecture, marine engineering and miscellaneous subjects. The papers presented at the mechanical engineering sessions were as follows:

"Recent Advances and Improvements in Founding," by Thomas D. West.

"Forgings from Early Times until the Present," by C. von Philip.

"Recent Progress and Present Status of the Art of Forging with Special Reference to the Use of Quick-Acting Forging Presses," by A. J. Capron.

"Permanent Shops, Pacific Terminals—Panama Canal," by H. D. Hinman and A. L. Bell.

"Machine Shop Equipment, Methods and Processes," by E. R. Norris.

"Machine Shop Equipment, Methods and Processes," by H. F. L. Orcutt.

"Automatics," by R. E. Flanders.

"High Temperature Flames in Metal Working," by H. R. Swartley, Jr.

"Power Plant Design," by H. S. Putnam.

"The Internal Combustion Engine of the Year 1915—The Gas Power System—A Survey of its Status in the Year 1915," by Prof. Charles E. Lucke.

"The Development of the Construction of Turbines in the Netherlands," by D. Dresden.

"The 1915 Steam Turbine," by E. A. Forsberg.

"The Diesel Engine in America," by Max Rotter.

"Developments in Modern Water Turbine Practice," by Dr. H. Zoelly.

"Water Wheels of Pressure Type," by Arnold Pfau.

"Hydraulic Power Development and Use," by J. D. Galloway.

"Water Wheels of Impulse Type," by W. A. Doble.

"Canadian Hydraulic Power Development," by Charles H. Mitchell.

"Safety Engineering," by F. R. Hutton.

"Motor Vehicles—Passenger Type," by Ethelbert Favary.

"Motor Vehicles—Utility Type," by A. J. Slade.

"Motor Tractors," by F. S. Davis.

"The Boiler of 1915," by Arthur D. Pratt.

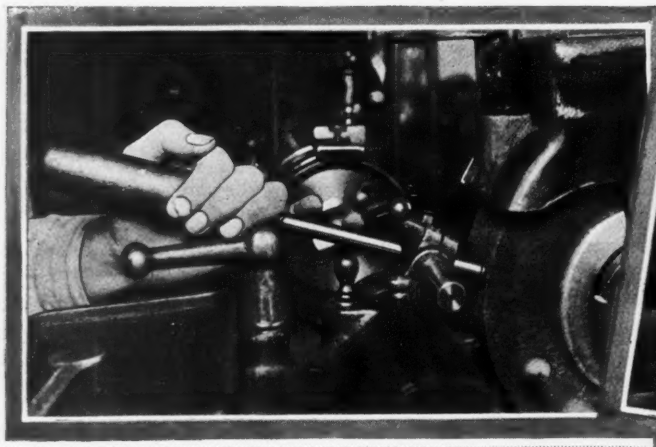
"Compressed Air in the Arts and Industries," by W. L. Saunders.

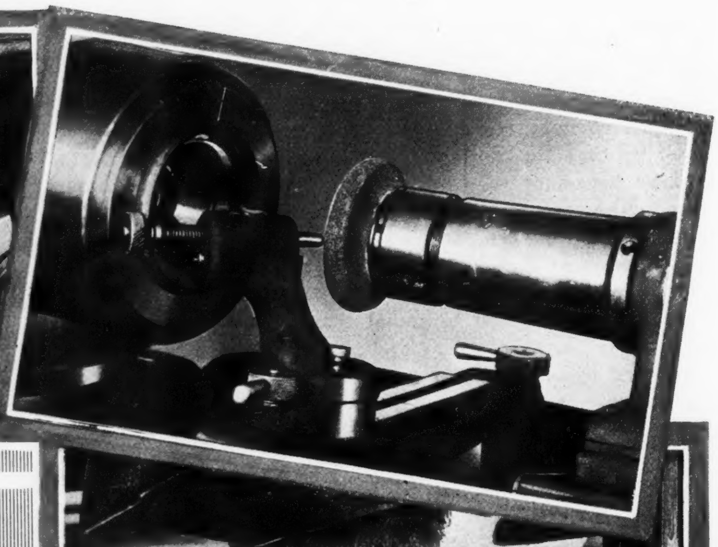
"Equipment, Process and Methods for Boiler Shop," by E. C. Meier.

* * *

WESTINGHOUSE SAVINGS FUND FOR EMPLOYES

The Westinghouse Electric & Mfg. Co. recently established a savings fund which offers facilities to the employes for the handling of their savings accounts. The fund is open to any employe of the company wherever he may be located, and he may become a depositor at any time and may withdraw his deposits at any time. The amount of any deposit cannot be less than ten cents, and it may be any multiple thereof; the deposit must be made from each regular pay. The deposit is limited to one account, the amount of which in any one year cannot exceed $500. The reason for this limitation is that the plan is intended to encourage the employe to save his earnings and when he has been successful up to this point, to allow him to handle his own finances thereafter. Interest is paid on the deposit at the rate of 4½ per cent, and is credited semi-annually. The Westinghouse Electric & Mfg. Co. acts as trustee and guarantees the deposits and interest. The rules provide that the amount of $100 or less may be withdrawn without notice, but an interval of two weeks must elapse before subsequent withdrawals can be made, and for withdrawals of more than $100 notice of one week must be given. An auditing committee not exceeding seven is to be elected by the depositors from among their own number. This committee will be given the opportunity of examining the condition of accounts at semi-annual interest periods, and its findings will be published.

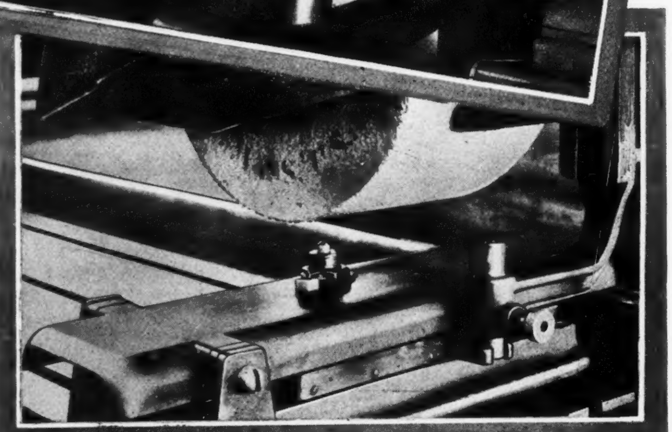


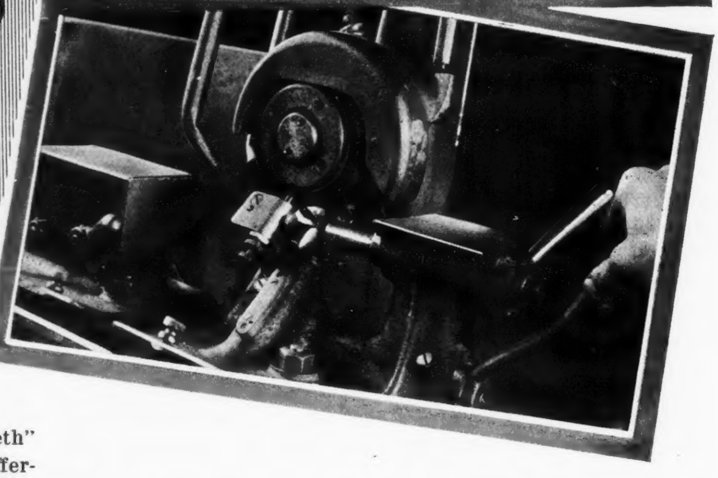


Grinding Wheel Truing Devices*

Attachments for Holding and Methods of Applying Diamond Tools

by Douglas T. Hamilton †





As is the case with all cutting tools, a grinding wheel, to give the greatest efficiency, must be kept in good condition—true and free-cutting. A modern grinding wheel may be considered as a milling cutter having an infinitely greater number of "teeth" or cutting points; these, however, are kept sharp in a different manner. In a milling cutter the teeth are resharpened when they become dull, whereas in a grinding wheel it is necessary to remove the dull "teeth" or grains of abrasive in order to present fresh and sharp cutting points to the work. This is generally done by means of a diamond tool held in various attachments as will be described later. There are two chief conditions which make it necessary to "resharpen" a grinding wheel—one is "loading" and the other "glazing."

"Glazing" and "Loading" of Grinding Wheels

The difference between "glazing" and "loading" of a grinding wheel is not always clearly understood. A "loaded" wheel is one whose cutting face has particles of the metal being ground adhering to it—one in which the openings or pores of the wheel face have been filled up with metal, leaving no room for clearance. It is not necessary that all the pores or openings between the cutting particles on the face of the wheel be filled up or loaded to prevent the wheel from free-cutting. The presence of a number of these pieces of metal on the face of a wheel prevents the wheel from cutting into the work and the "loaded" places will, of course, create heat.

A "glazed" wheel is one whose cutting particles have become dull or worn down even with the bond, the bond being so hard that it does not allow the dulled cutting particles to tear out. In a glazed wheel the cutting particles and the bond at the extreme surface of the wheel are of the same radius. Continued work with a wheel that glazes increases the smoothness of the wheel face and consequently decreases its cutting capacity.

On cylindrical grinding, loading may be caused by using a wheel of too hard a bond and running it at too slow a speed. It also may be caused by crowding a hard wheel to a great depth of cut—greater than the size of the grains. When a hard wheel is revolved at too slow a speed with plenty of power, the grains withstand this crowding action without breaking away and thus pick up the metal. One remedy for loading is to increase the speed of the wheel. Glazing takes place when the wheels are too hard and revolve at too fast a speed. The remedy for this is to decrease the speed of the wheel. If the speeds are right use a softer wheel. Loading and glazing of the wheel make excessive truing necessary and this, of course, means greater wheel wear. For truing a hard wheel, a sharper diamond is used than for truing a softer wheel. The reason for this is that a sharp diamond leaves the surface of the hard wheel with more clearance, and consequently this surface will cut for a greater length of time. Increasing the work speed also makes the harder wheel, or one having a tendency to glaze, cut more freely.

* For information on grinding previously published in MACHINERY, see "Selection of Grinding Wheels," in the October, 1915, number, and articles there referred to.
† Associate Editor of MACHINERY.

The sample of ground work shown in Fig. 1 illustrates clearly the kind of finish produced by a wheel under various conditions. To the left of this illustration is shown a section of the work, enlarged about eight times, which indicates the finish secured when the face of the wheel is not true; in the center is shown the finish secured when the wheel face is true and sharp; and at the right is shown the effect produced by a dull or glazed wheel. For a commercial finish the wheel should be kept true and sharp, and the best way to accomplish this is to make frequent use of the diamond tool.

Selecting Diamonds

For truing and sharpening wheels used on automatic grinding machines, the most satisfactory tool is the diamond. Carbon, carborundum, alundum blocks, etc., are used to some extent to remove the glazing effect from the face of a wheel, but for truing, the diamond is the most satisfactory. The question of selecting diamonds is an important one, and there is considerable difference of opinion as to which is the best stone to use. The diamonds generally used in tools for truing grinding wheels are of two kinds, the carbon or black diamond and bort. The black diamond is non-crystalline in structure; its color varies, but it is often of a dark purple brown. The bort is a semi-transparent stone or an imperfect "brilliant." It is not as hard as the black diamond, and is also considerably lower in price. For truing soft wheels, bort can be used, but as a general rule, the black diamond is cheaper in the long run.

One prominent manufacturer states that it has been his experience that the Brazilian bort or brownstone, sometimes called "South African premiers," are the best for truing wheels. These stones are considerably cheaper than the black diamond. For instance, a brown diamond can be purchased for fifteen dollars, equal in size and weight to a black diamond costing between seventy and seventy-five dollars. In selecting the diamond, care should be taken to see that no seams appear, as such stones are likely to crack, and the smooth skin stone is the one most likely to prove satisfactory. Of course the more points a stone has, the better it is adapted for truing grinding wheels.

Setting Wheel Truing Diamonds

In order to present the diamond to the work, it is necessary that it be held in a holder. Various materials and methods are employed for this purpose. Copper, brass or soft steel rods are generally used, and the diamond is either held in place by peening over the end of the bar or pouring in melted spelter. When spelter is used, it should be poured into the hole first before the diamond is inserted. If the diamond is inserted first, it is impossible to get the spelter to flow beneath it and hold it rigidly. The best method is to drill the hole slightly deeper than the highest point of the diamond, and of a size that will admit the diamond freely. Then the hole should be closed in just enough to make it out of round. The spelter is then poured into the hole, filling it completely, and the diamond, held in a pair of tweezers, is put into the liquid spelter until it strikes the bottom of the hole. In doing this, an amount of spelter equal to the size of the diamond is pushed out, and when this excess of spelter makes its appearance it is certain that there are no vacant spots under the stone. After the spelter has cooled, the end of the rod in which the diamond is located can be shaped in the customary manner.

Another quicker method that is also in general use is to drill a hole in a piece of soft steel slightly larger than the diamond and of a depth sufficient to completely cover the stone. The diamond is then inserted and the end of the rod peened over to entirely cover it. The peening is done by means of a small flat-headed chisel or a set, and should be done carefully to avoid breaking the stone. As the result of peening, the diamond is covered entirely by the metal, and this is removed by grinding, exposing the diamond and making it ready for use. Copper rods are also used for holding diamonds and the same method of peening is adopted.

Still another method of setting a black diamond, which differs slightly from that just described, is as follows: A hole is drilled in the end of a ⅜-inch soft steel rod just large enough to admit the diamond. The diamond is then placed in the hole with the largest end at the bottom, and the metal is subsequently peened around sufficiently to hold the stone in place. The diamond and the holder are then heated to a white welding heat, and by light blows, using a small hammer, the metal is completely closed around the stone. The holder is then taken to an emery wheel and ground until the diamond touches the wheel. The welding heat does not appear to affect the diamond and the light blows close the metal completely around it, holding it rigidly in place.

Methods of Applying Diamonds to the Truing of Grinding Wheels

The terms "dressing" and "truing," as applied to grinding wheels, are sometimes confused; they indicate two entirely different operations. "Dressing" a wheel is done to rough it up, or in other words, remove the dull grain from the bond. This is done with a wheel dresser, and is applicable more particularly to grinding wheels used for snagging castings, etc. Truing a grinding wheel, as understood by users of wheels for cylindrical and accurate work, is not the roughing of the wheel but the making of an accurate and concentric face. Truing may be divided into two classes: first, that done for the purpose of sharpening the wheel, as well as

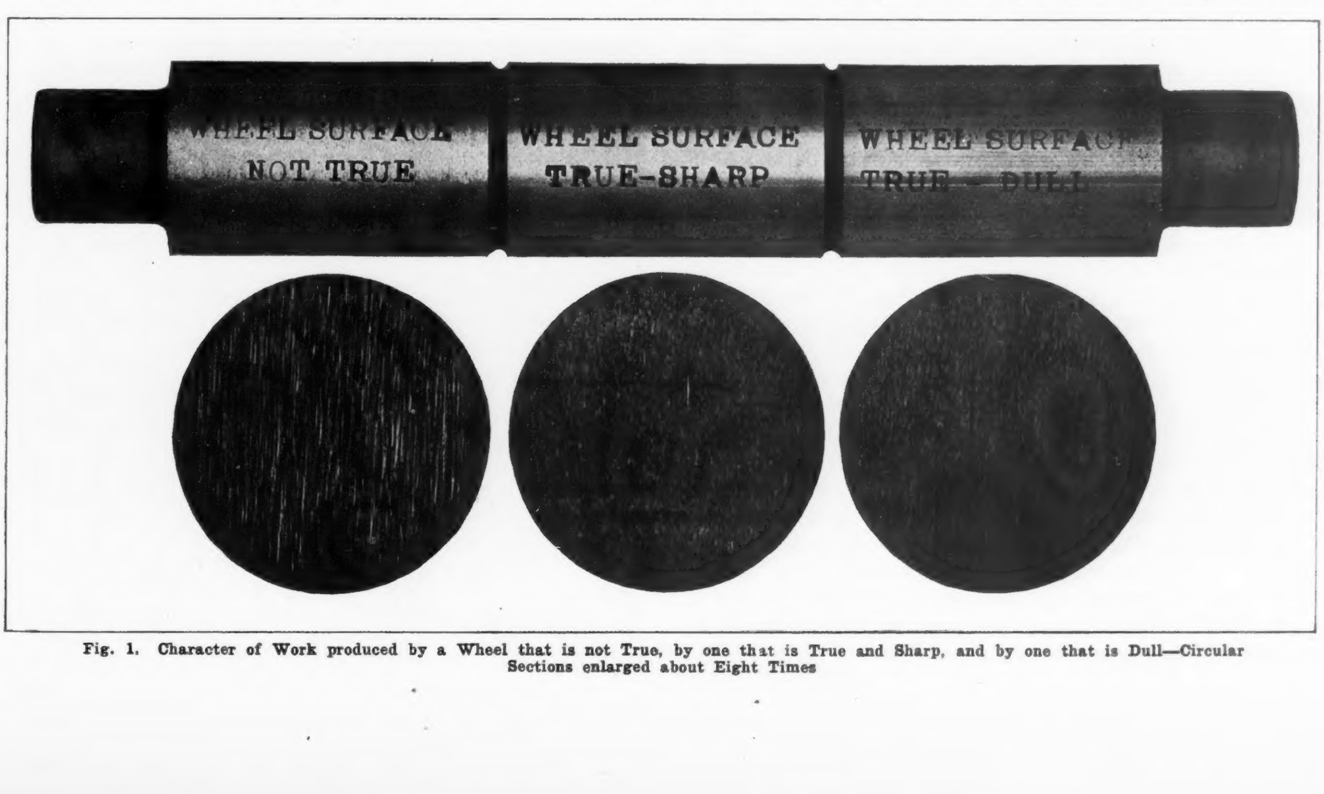


Fig. 1. Character of Work produced by a Wheel that is not True, by one that is True and Sharp, and by one that is Dull—Circular Sections enlarged about Eight Times

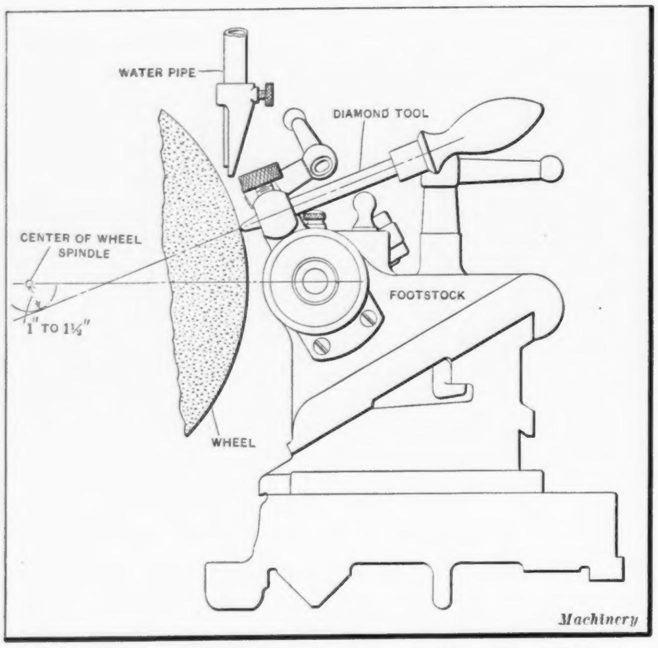


Fig. 2. Relation of Diamond Point to Grinding Wheel Face

making it perfectly true, and second, that done to dull the wheel, which, while making it perfectly true, produces a smooth surface on the face of the wheel. Accurate truing is done with a diamond which should always be held in a fixed toolpost, and never in the hand. There should always be a liberal supply of lubricant or water flowing on the diamond while the truing is being done. Keeping the diamond wet only part of the time wears it unduly and also prevents the operator from securing a perfectly smooth-face wheel.

Different Methods of Truing Grinding Wheels

On modern cylindrical and surface grinding machines, a relatively coarse grain soft bond wheel is commonly used for

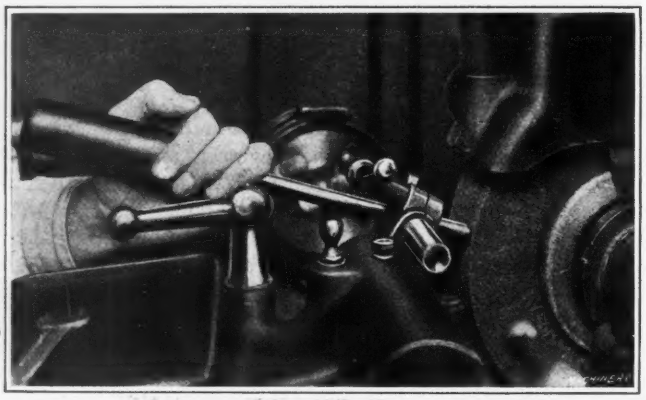


Fig. 3. Truing Face of Grinding Wheel by Means of Ordinary Diamond Holder

removing the greater part of the material, especially in commercial grinding, and this wheel is usually of so coarse a grain that it will not produce a fine enough finish when the wheel face is sharp, as for roughing. For finishing, the method adopted is as follows: After removing the greater amount of the material, leaving enough for finishing, the face of the wheel is trued with a diamond that does not have a very sharp point, but preferably has a slightly rounded or perhaps a considerably rounded point. Then by traversing this diamond slowly across the face of the wheel, holding it in the fixed post, a surface is produced which is smooth and at the same time perfectly true. This surface is a temporary one on the otherwise coarse wheel; by carefully bringing the wheel in on the work, so as not to disturb the surface, a fine finish on the work is secured. In other words, the quality of the finish on the work depends largely on the quality of the surface on the wheel. When a second piece is to be ground, that is, roughed out, the wheel is brought in rapidly on the work, taking a heavy cut, and the previously smooth surface entirely disappears.

The method of truing a hard bond fine grain wheel is just the reverse from that described. Instead of using a blunt rounded point diamond, it is necessary to use a diamond with a sharp point in order that the surface may be roughed up. Water must flow on the diamond continually, and instead of a very slow traverse of the diamond across the wheel, the diamond is traversed rapidly, taking light cuts. For accurate cylindrical grinding, all other factors being considered, the most profitable wheel to use is often one which requires frequent truing.

Relation of Diamond Point to Center of Wheel-spindle

In truing the average grinding wheel, and especially when using a comparatively hard bond wheel on a cylindrical grinding machine, it is necessary to keep fresh cutting facets on the diamond presented to the wheel. In order to do this, the diamond point must be presented at a certain angle to the face of the wheel. The diagram shown in Fig. 2 illustrates a standard diamond truing tool being applied to a grinding wheel. In this case, it will be noticed that the holder is presented at such an angle to the face of the grinding wheel that by continuing the line representing the axis of the dia-

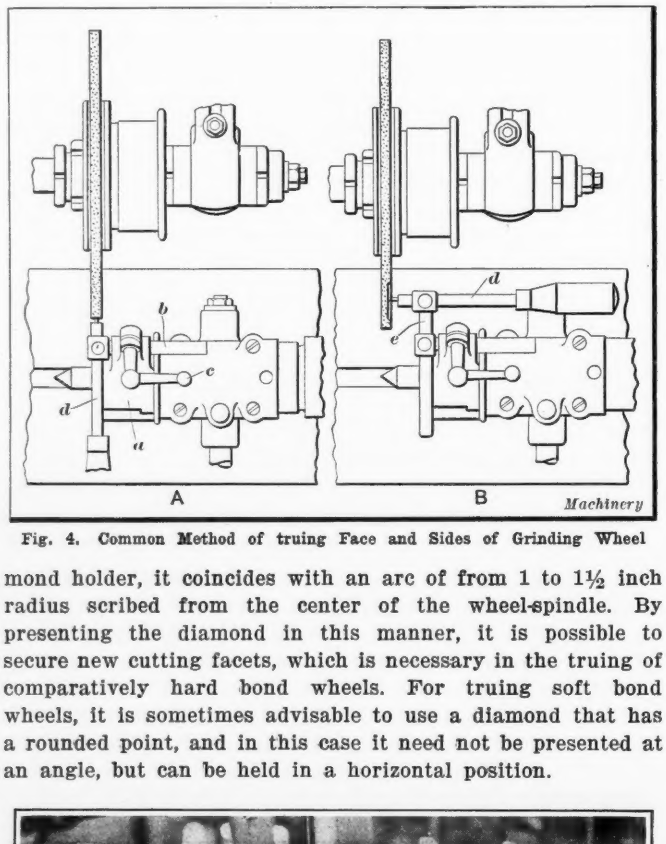


Fig. 4. Common Method of truing Face and Sides of Grinding Wheel

mond holder, it coincides with an arc of from 1 to 1½ inch radius scribed from the center of the wheel-spindle. By presenting the diamond in this manner, it is possible to secure new cutting facets, which is necessary in the truing of comparatively hard bond wheels. For truing soft bond wheels, it is sometimes advisable to use a diamond that has a rounded point, and in this case it need not be presented at an angle, but can be held in a horizontal position.

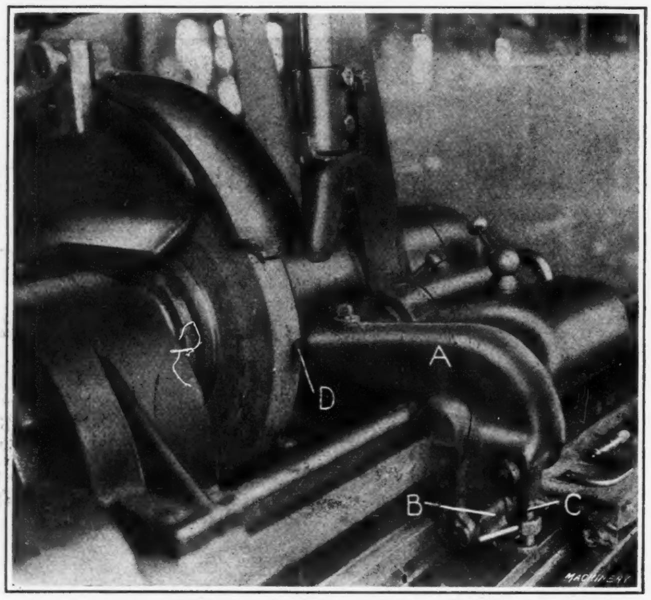


Fig. 5. Wheel Truing Device that can be used without changing Position of Wheel-slide

Common Method of Truing Face and Sides of Grinding Wheel

Fig. 4 shows the conventional method of applying a diamond tool to the face and sides of the grinding wheel. At *A* is shown the truing of the face of the wheel. In this case, a diamond holder *a* is held on the footstock of the grinding machine and carries a bolt *b*, which is clamped in position by means of lever *c*. Extension holder *b* carries a diamond holder *d*. To apply this type of wheel truing device to the side of the wheel, it is necessary to insert an additional holding rod *e*, as shown at *B*, which occupies the same position as the diamond holder shown at *A*. Grinding wheels are only trued on the side when it is necessary to face a shoulder. When the opposite side of the wheel to that shown in the illustration is to be trued, the wheel is brought over further and the position of diamond holder *d* is reversed in holder *e*.

Fig. 3 shows the wheel truing device illustrated in Fig. 4 being applied to the face of the grinding wheel. In this case it will be noticed that the diamond holder is held as close as possible to the diamond. This is necessary in order to retain the holder rigidly and prevent chatter and chipping of the diamond point. In applying the diamond where an ordinary finish is desired on the face of the wheel, usually the power feed is thrown in to traverse the diamond across the wheel, and a copious supply of cutting lubricant or water is provided to keep the diamond point cool, and to give an even finish on the surface of the wheel.

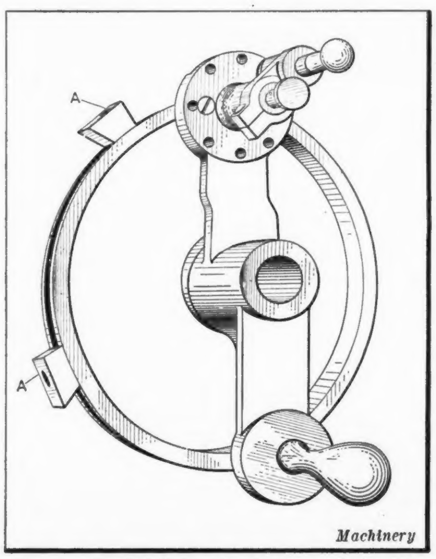


Fig. 6. Special Index Crank designed for Use on Norton Plain Grinding Machines for truing Different Diameters on Wheel Face

Parallel Wheel Truing Devices for Cylindrical Grinding Machines

One of the most necessary requirements for accurate work is to keep the wheel face true and free-cutting. It is therefore essential that the wheel truing device be capable of quick application in order to reduce the time necessary for truing. With some of the wheel truing devices on the market, it is necessary to change the position or location of the wheel in relation to the work, in order to true its face. This takes considerable time and necessitates resetting each time the wheel is trued. A wheel truing device that overcomes this objectionable feature is illustrated in Fig. 5. This comprises

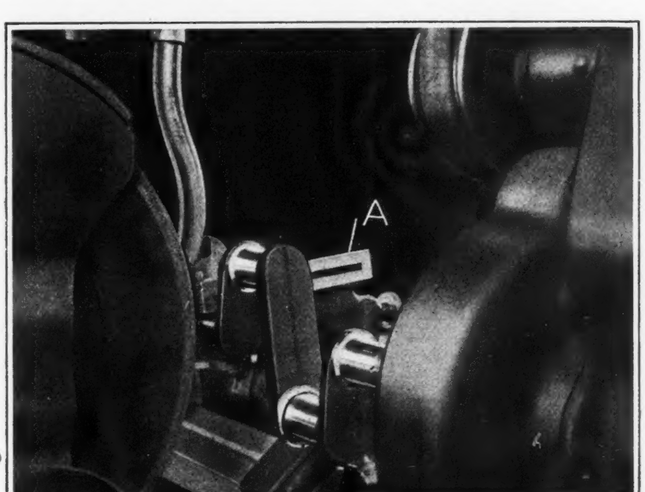


Fig. 7. Simple Wheel Truing Device used on Landis Crankshaft Grinders

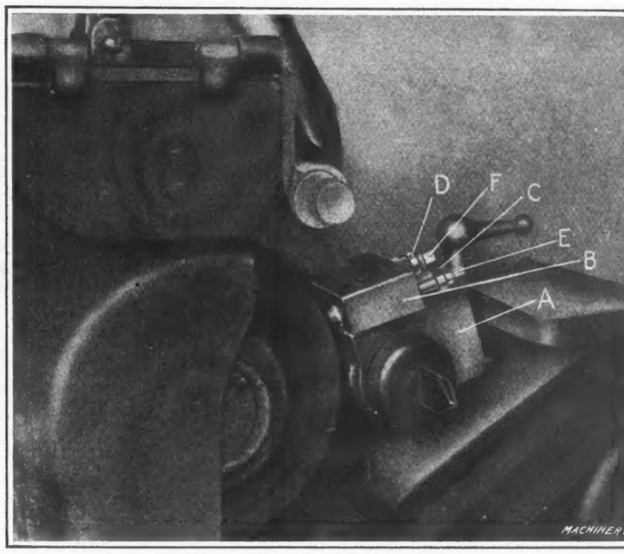


Fig. 8. Multiple Diameter Wheel Truing Device for Use on Brown & Sharpe Plain Grinding Machines

a cast-iron bracket *A* which is fitted to and held to the front of the table of a Norton plain grinding machine.

The method of clamping is simple, there being a small shoe *B* hinged in the lower portion of the bracket, and against which an adjustable clamping bolt *C* rests. This device is effective in holding the bracket rigidly in position. The diamond holder proper *D* is held in the front end of the bracket by a set-screw, as shown. In using this device, the work is removed from the centers and the wheel truing device clamped in position. After the face of the wheel has been trued, the fixture is removed and the work again inserted. In setting up the machine, however, the diamond point is located so that it trues the wheel in such a position in relation to the centers that the work when placed on the centers is ground to practically the required diameter. The setting of the diamond

Fig. 9. Radius Wheel Truing Device for Use on Norton Plain Grinding Machines

is not changed after this, and as the wheel is worn down by frequent truing, its relation to the centers is approximately maintained. In this way, very little adjustment of the wheel-slide is necessary which, of course, reduces the time usually spent in truing the wheel. In order to take care of small- and large-diameter work, brackets *A* are made in several lengths so that it is not necessary to have the diamond holder project too far from the bracket, which would be objectionable.

Another wheel truing device that is used quite extensively on Landis crankshaft grinders is shown in Fig. 7. This comprises a very simple holder *A*, which is provided with an elongated slot through which a set-screw passes that clamps it to the face of the steadyrest casting. With this device, it is not necessary to remove the work from the centers at all to true the face of the wheel. In use, the diamond holder *A* is released and pushed in between the throws of the crankshaft; the wheel-slide is then traversed to true the face of the wheel. After truing, the set-screw is released and holder *A*

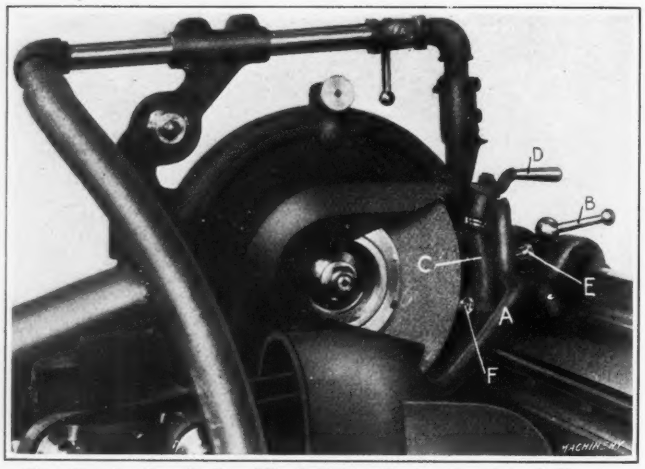


Fig. 10. Another Radius Wheel Truing Device for Use on Norton Plain Grinding Machines

pulled back out of the way. This device has proved very effective and rapid in truing the wheel on Landis crankshaft grinding machines.

Multiple-diameter Wheel Truing Attachment

The application of wide-face grinding wheels to the production of shoulder shafts or other multiple-diameter work, has made necessary the designing of attachments for either bringing the wheel into different positions accurately, or truing the face of the wheel to different diameters, without the usual trouble of manipulating the index stop. When the sum of the lengths of all the diameters to be ground is less than the width of the wheel, it is most economical to true several diameters along the wheel face. The work is then ground in the ordinary manner, by simply feeding the wheel straight in on the work without any lateral traverse, until the correct diameter is reached. If the difference in size between the various diameters is small, it does not pay to produce these different shoulders in the rough-turning operation; it is preferable to turn the several diameters straight and depend on the wheel to produce the slight differences. This imposes a little more work on some parts of the wheel, and the truing will be more frequent, but this usually is cheaper than producing the slight differences in the diameter by turning.

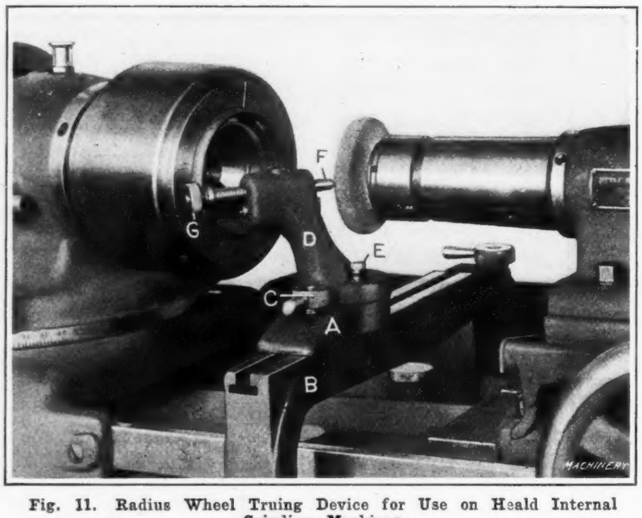


Fig. 11. Radius Wheel Truing Device for Use on Heald Internal Grinding Machines

When various portions of a shaft are of such a length that the entire face of the wheel does not cover them, the work must be traversed and means must be employed for accurately locating the wheel on each diameter. One method of accomplishing this is shown in Fig. 6. This device in use is attached to the regular index crank of a Norton plain grinding machine. It comprises a metal ring in which a dovetailed slot has been turned, and in which small blocks *A* are held by means of screws. These are located around the periphery of the ring in the desired position. By numbering or lettering these blocks and correspondingly numbering or lettering the working drawings, the operator knows just how far in to bring the wheel for the various diameters on the work.

In order to true the wheel so as to grind two diameters at one setting, the proper procedure is to first true the wheel straight across the face, with the first block resting against the stop arm on the machine. Then the ring should be turned around until the second block rests against the stop arm. The wheel has therefore been advanced toward the diamond by a certain predetermined amount. If now the diamond is traversed along the wheel face for the required distance, a small portion of the wheel will be smaller in diameter than the remainder of the wheel; therefore, if the wheel is brought straight in on the work it will produce two diameters, the larger of these being made by the smaller diameter on the wheel.

Another multiple-diameter wheel truing device which was designed for a particular job is shown in Fig. 8. This is attached to the footstock of a Brown & Sharpe plain grinding machine. The fixture consists of a block *A*, which is bored out and encircles the front end of the footstock; it is clamped in position by means of bolts. The top face of this block is machined out with a dovetailed groove to receive a second block *B*. This second block, which is provided with a dovetailed slide, is held to the first block as shown, and carries two separate holders *C* and *D*. These are adjusted by means of graduated collar screws *E* and *F* so that movements of 0.001 inch can be obtained. In use, this wheel truing device is brought over in contact with the face of the grinding wheel, and then a stop on the front of the machine is set and the table traversed back and forth until the wheel is trued. The relative positions of the diamond points take care of the two diameters on the wheel.

Radius Wheel Truing Devices

In grinding certain classes of work it is necessary to produce a fillet near a shoulder or other circular surface, and for this requirement a radius wheel truing device is generally provided. Fig. 9 shows a simple but effective wheel truing device for truing the radius on the grinding wheel, which can be set, in addition, for truing the wheel parallel with the axis. It comprises a bracket *A* clamped to the footstock center by means of a clamping-screw *B*, and a projecting arm for fastening it to stud *C*. The radius wheel truing fixture proper comprises a bracket *D*, capable of swiveling in the seat provided in the lower end of bracket *A*. Bracket *D* carries the diamond holder *E* that is held in place by a set-screw as shown. It is also provided with a slot in which a plug *F* fits.

In using this device for producing a radius, thumb-screw *G* is released and plug *F* pulled back. This allows a free movement of bracket *D*, and by gripping holder *E* the operator can true a radius on the wheel. To true the face parallel with the grinding machine centers, plug *F* is pushed in, thumb-

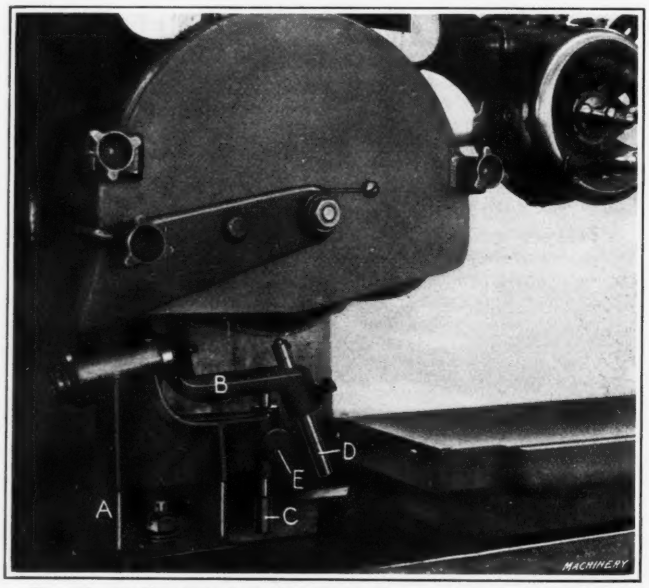


Fig. 12. Radius Wheel Truing Device for Use on Norton Surface Grinding Machines

screw *G* tightened and then the table traversed, moving the diamond point back and forth in front of the wheel. A somewhat similar device was shown in Fig. 71 in the April number of MACHINERY.

The radius wheel truing device shown in Fig. 10 differs from that shown in Fig. 9 chiefly in the method of clamping it to the machine and in the manner in which the diamond holder is held and rotated. This device consists of a bracket *A* clamped to the Norton plain grinding machine table by a clamping lever *B*. The lower portion of bracket *A* is yoke shaped and carries the diamond holder bracket *C* in the manner illustrated. This bracket can then be swung by operating lever *D* when it is necessary to true a radius on the wheel. For parallel truing of the grinding wheel face, plug *E* is pushed in and fits in a hole provided in bracket *C*, holding the bracket rigidly in position for parallel truing. The diamond is held in the holder *F*, the external diameter of which is threaded to receive a nut used for adjusting purposes.

Radius Truing Device for Internal Grinding Wheel

A simple device for truing wheels for internal grinding on a Heald internal grinding machine is shown in Fig. 11. It comprises a bracket *A*, provided with a locating key and held to the standard yoke or bracket *B* by means of a clamping bolt and nut *C*. The diamond holder proper is held in a bracket *D* that is free to swivel on the base when plug *E* is lifted up. When this plug is pushed down, the device can be used for truing the wheel parallel with the axis of the spindle. The diamond is held in a holder *F*, the rear portion of which is threaded, enabling it to be adjusted back and forth by turning knob *G*, in order to true the wheel to various radii.

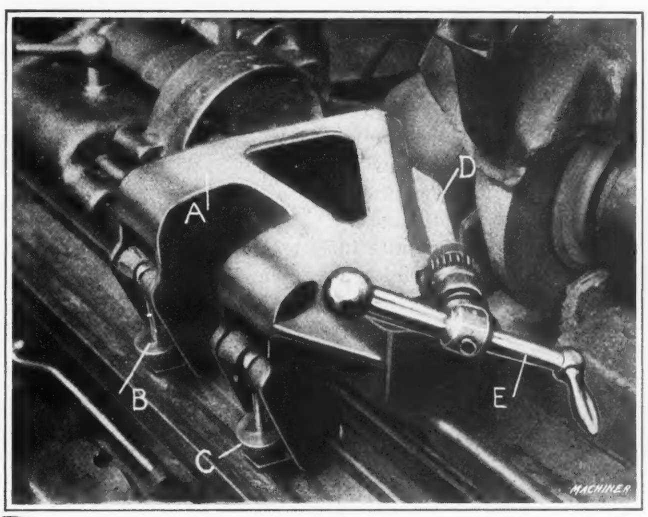


Fig. 15. Angular Wheel Truing Device for Use on Plain Cylindrical Grinding Machine

Radius Wheel Truing Device for Surface Grinding Machine

An interesting wheel truing device for use on the Norton surface grinding machine is shown in Fig. 12. As the illustration shows, this comprises a main bracket *A* provided with two extension members, one of which acts as a fulcrum point for the wheel truing holder *B*, whereas the other holds plug *C* to adapt the device for truing the wheel straight. The diamond holder *D* is held in bracket *B* and is adjustably mounted. In using this device to true a radius on the corner of a wheel, thumb-screw *E* is released

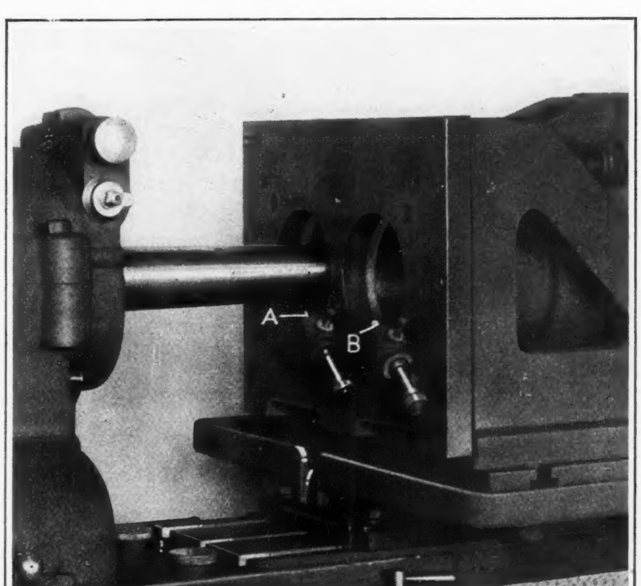


Fig. 13. Devices for truing Grinding Wheel on Heald Cylinder Grinding Machine

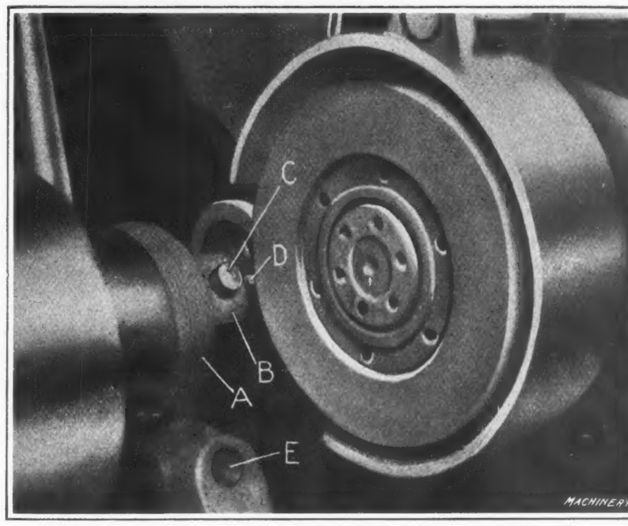


Fig. 14. Simple Wheel Truing Device for Use on Bryant Two-spindle Chucking Grinder

and plug *C* pulled down. This allows a free oscillating movement of holder *B*. When a straight face is to be trued on the wheel, plug *C* is pushed up until it contacts with a hole in bracket *B*, then screw *E* is tightened, and the wheel-head moved back and forth in order to true the wheel parallel with the axis of the wheel-spindle.

Wheel Truing Device for Cylinder Grinding Machines

In the grinding of cast-iron cylinders for automobile engines, which must be finished to accurate dimensions and also have a good finish, it is necessary that the grinding wheel be kept in good condition, which requires frequent truing of the wheel. The two small devices shown at *A* and *B* in Fig. 13 do this work satisfactorily. It will be noticed by referring to this illustration that the front of the work-holding fixture carries two brackets which hold split bushings that are acted upon by set-screws. Screwed into these bushings are two threaded diamond holders carrying a diamond at their points. With these devices, it is possible to true the wheel quickly, after taking roughing cuts from each cylinder bore, thereby obtaining a good surface on the wheel for finishing. In operation, the work-table is traversed so that the diamonds are carried forward and backward past the face of the grinding wheel, the oscillating movement of the wheel-head, of course, being stopped while the truing is being done.

Wheel Truing Device for Use on Bryant Two-spindle Chucking Grinder

A simple but effective means of holding a diamond for truing the external grinding wheel on a Bryant two-spindle chucking grinder is shown in Fig. 14. It is usually quite difficult to apply the diamond for this work; but this is easily taken care of in this particular case by making a holder of the same shape as the work to be ground, and then holding it on the fixture in which the work is held. To the front face of this piece *A* is attached a small bracket *B* in which the diamond holder *C* is held by screw *D*. This device proved very effective and is easily put on and taken off. The wheel working on the internal diameter of the work is trued up by an ordinary diamond held in bracket *E*.

Angular Wheel Truing Device for Use on Plain Cylindrical Grinding Machine

Fig. 15 shows an angular wheel truing device for truing the wheel to a bevel shape, or in this case, to an angle of 36

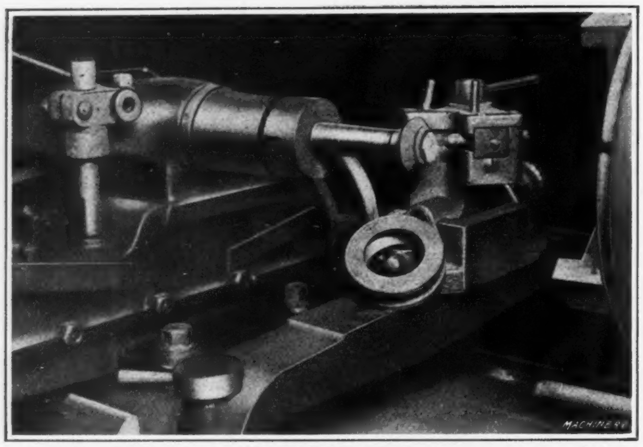


Fig. 16. Double Angle Wheel Truing Device shown set up and in Operation on Heald Internal Grinding Machine

degrees with the axis of the grinding machine centers. The fixture is of comparatively simple design. The bracket *A* is fastened to the table of a Norton grinding machine by clamps *B* and *C* that are similar in construction to those shown in Fig. 5. Bracket *A* carries a slide *D* in which the diamond holder is retained. This slide is operated longitudinally by means of a rack and pinion, receiving motion from handle *E*. The fixture shown here can only be used for truing the bevel; for truing the straight portion of the wheel the ordinary wheel truing device must be used.

Angular Wheel Truing Device for Cone-shaped Ball Races

An interesting double-angle wheel truing device for use in forming a wheel for making a cone-shaped ball race is shown in Fig. 16 and in detail in Fig. 17. Referring to the latter illustration, it will be seen that this device comprises a base *A* whch is machined out to fit a bracket *B* that is adjusted by screw *C*. The operating mechanism of this device is quite interesting: an eccentric bolt *D* passes down through block *B* and is prevented from pulling out by means of a pin fitting

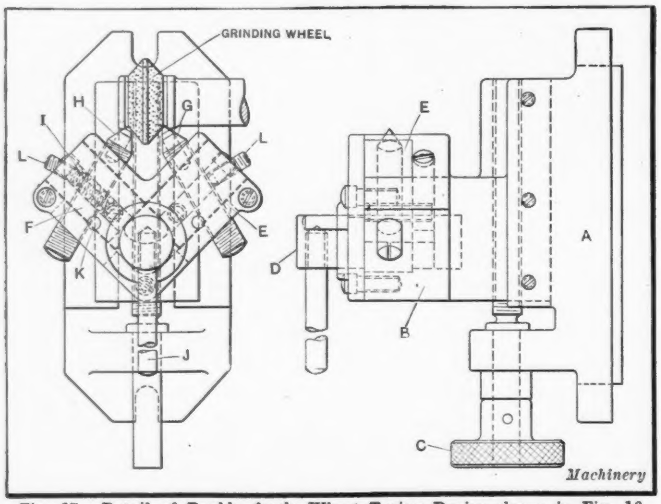


Fig. 17. Detail of Double Angle Wheel Truing Device shown in Fig. 16

in a groove in the lower end. Opposite the eccentric portion of this pin are located two slides *E* and *F*, carrying the diamond holders *G* and *H*. The rear ends of these slides are curved slightly to conform to the cam, and are kept back in contact with it by means of two coil springs *I*, only one of which is shown in the illustration.

The method of operating the fixture is to swing handle *J* in one direction, say to the left, thus forcing out the slide carrying diamond holder *G*, which travels along the angular face of the wheel until handle *J* strikes stop *K*. The handle is then forced in the opposite direction and the other diamond holder comes into play. Screw *C* is operated to bring both holders into the correct working position relative to the wheel. The diamond holders, which are provided with a thread and are screwed into the slides, are set by means of a gage of the same shape and size as the work. They are then clamped in position by set-screws *L*.

Attachment for Use on Cylindrical Machines for Truing Grinding Wheels to Irregular Form

For some classes of work it is necessary that the wide face wheel be trued not only to different diameters but also to irregular form. For accomplishing this it is necessary to use a device in which the form is controlled by means of a cam or other mechanism of a similar nature. Figs. 18 and 19 illustrate such a device, Fig. 18 showing it attached to a Norton plain grinding machine, whereas Fig. 19 shows it removed and partly dismantled.

Referring to the latter illustration, which shows a front

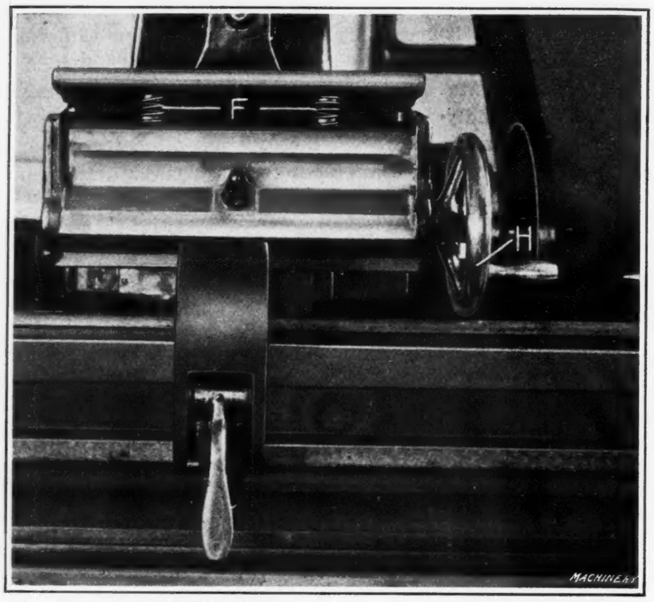


Fig. 18. Cam-controlled Device designed for forming Irregular Shapes on Face of Grinding Wheel on Norton Plain Grinding Machines

view of this device, it will be seen that it comprises a former plate *A*, which in this case is perfectly plain, a diamond holder or plate *B*, and a diamond holder *C*. Carriage *B* is held on pivots *D*, and as shown in Fig. 18, is kept in contact with the cam by means of coil springs *F*. Cam *A* is held in a carriage or slide *G* that is traversed laterally by means of a screw to which handwheel *H* is attached. By rotating this handwheel, the carriage carrying cam *A* is traversed and the face on the cam imparts the desired in and out movement to the plate carrying the diamond. The entire device is clamped on the table of the grinding machine with a clamping device as shown in Fig. 18. A wheel truing device of simpler construction than that shown in Figs. 18 and 19 was illustrated in Fig. 72 in the April number of MACHINERY.

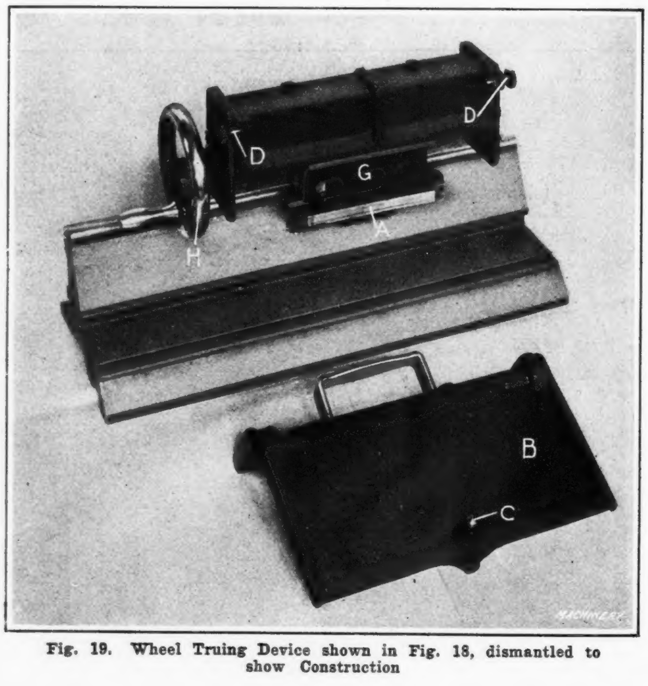


Fig. 19. Wheel Truing Device shown in Fig. 18, dismantled to show Construction

Wheel Truing Device for Surface Grinding Machine

In applying a diamond holder to a wheel held in a surface grinder, the holder should, when possible, be held on the table under the wheel and not up at the side of the wheel in the same horizontal plane as the wheel-spindle. Holding the diamond truing device on the table reduces the chances of chatter, and it is also much more easily applied in this way. Fig. 20 shows a simple diamond holder for use on a Heald piston ring grinding machine. Referring to this illustration, it will be noticed that this consists simply of a plate *A* in which the diamond holder *B* is retained, plate *A* being held on the magnetic chuck. The diamond holder is presented to the wheel by traversing the wheel back and forth past it, the work-table remaining stationary.

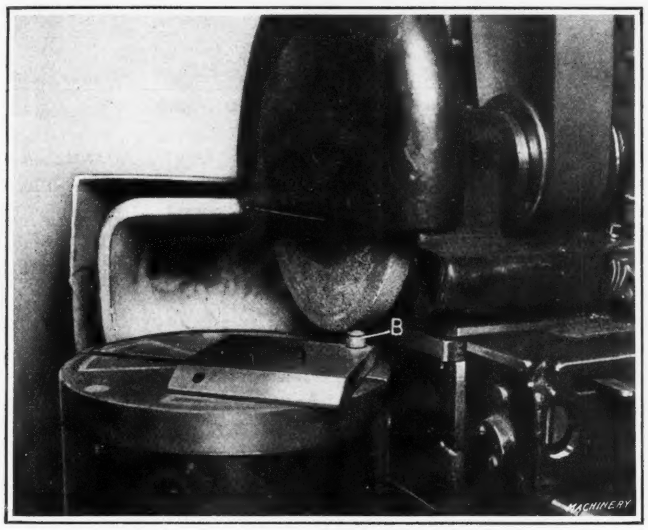


Fig. 20. Simple Wheel Truing Device for Use on Heald Piston Ring Grinding Machine

Wheel Truing Attachment Used on Wilmarth & Morman Surface Grinding Machine

The wheel truing device shown in Fig. 21 is held on the wheel guard or hood as illustrated, and has several slides. Slide *A* which holds diamond holder *B* is adjusted up and down along the face of slide *C* by means of screw *D*. Slide *C*, in turn, is moved along the gibbed slide on bracket *E* by means of handle *F*. The screw to which handle *F* is attached is of coarse pitch, enabling slide *C* to be traversed rapidly. The vertical screw *D* is of fine pitch, enabling accurate adjustment of the diamond to be made. With this contrivance it is unnecessary to remove the wheel truing device in order to grind the work.

Wheel Truing Device for Crowning Pulleys

The attachment shown in Fig. 22 is used chiefly for truing the face of the grinding wheel when it is desired to use it for crowning pulleys by feeding straight in on the work. This consists primarily of a bracket *A*, fastened to the grinding machine table by clamp handle *B* as shown, and carrying an adjustable slide *C* in which the diamond holder is retained. Slide *C* is held on bracket *D* clamped to bracket *A*,

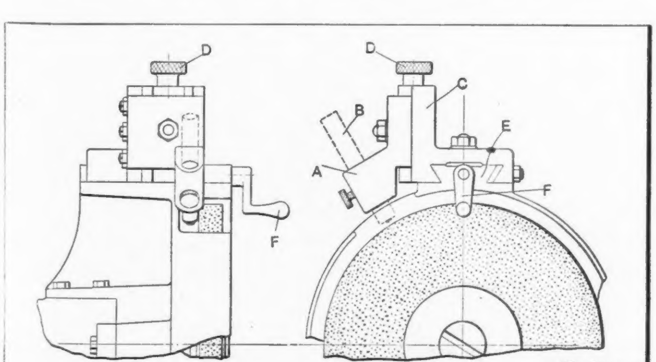


Fig. 21. Wheel Truing Device used on Wilmarth & Morman Surface Grinding Machines

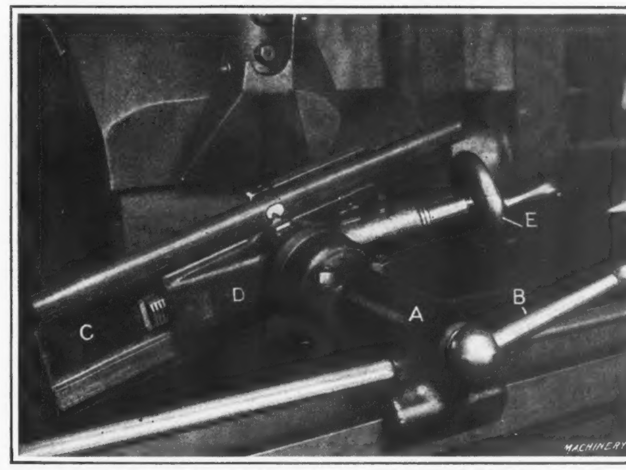


Fig. 22. Wheel Truing Device used in producing Concavity in Face of Wheel for crowning Pulleys on Norton Plain Grinding Machines

and is free to swivel when the clamping bolt is released. The boss on bracket *D* is graduated so that the required amount of inclination of the slide in relation to the axis of the wheel-spindle can be obtained. The degree to which the wheel truing slide is tilted determines the amount of concavity on the wheel face which, of course, governs the height of the crown on the pulley. Slide *C* carrying the diamond is moved back and forth by means of a rack and pinion operated by handwheel *E*.

Reference to the diagram Fig. 23 will show the manner in which the face of the grinding wheel is trued concave. Line *A* shows the path that the diamond takes when the holder is set off at an angle of 30 degrees with the axis or center line of the wheel-spindle, and at the top of this illustration will be seen the amount of concavity produced with the slide set in this position. The reason for this concave form is that the diamond in passing across the wheel is closer to the axis of the wheel when passing over the center line; consequently, the wheel is trued concave when the diamond is traversed back and forth. Different degrees

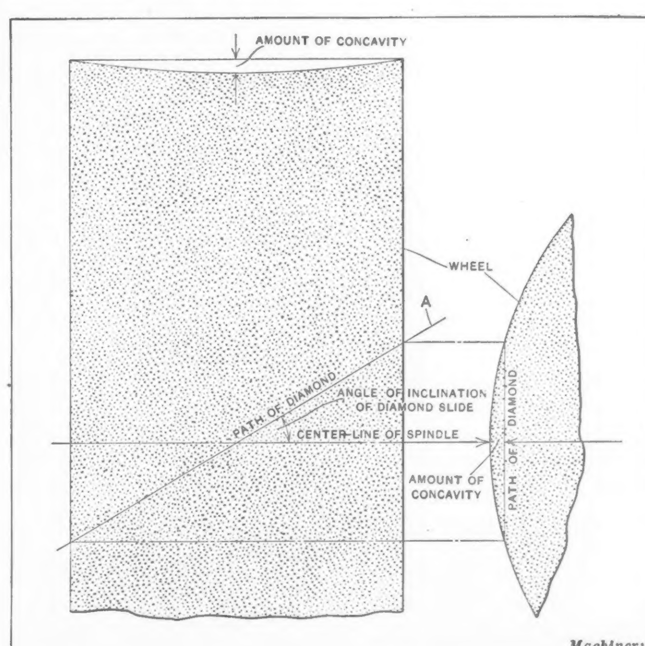


Fig. 23. Diagram showing Principle upon which Wheel Truing Device illustrated in Fig. 22 operates

of depth can be obtained by changing the angle of the path that the diamond makes in traveling across the wheel face. This particular attachment provides for truing from a straight surface to a concavity having a depth of $\frac{1}{4}$ inch. In width, this attachment will true wheels up to 12 inches.

Device for Truing Wheel to Irregular Form on Surface Grinding Machine

Figs. 24 and 25 show a wheel truing device that is used on a Norton surface grinding machine for truing the face of

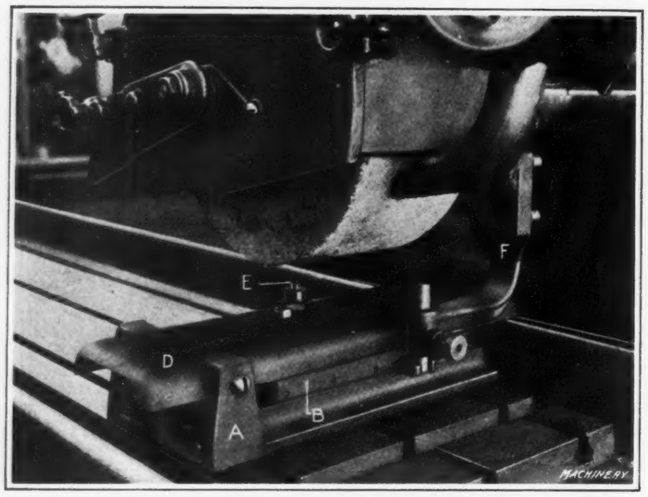


Fig. 24. Device for truing Face of Wheel to Irregular Form on Norton Surface Grinding Machine

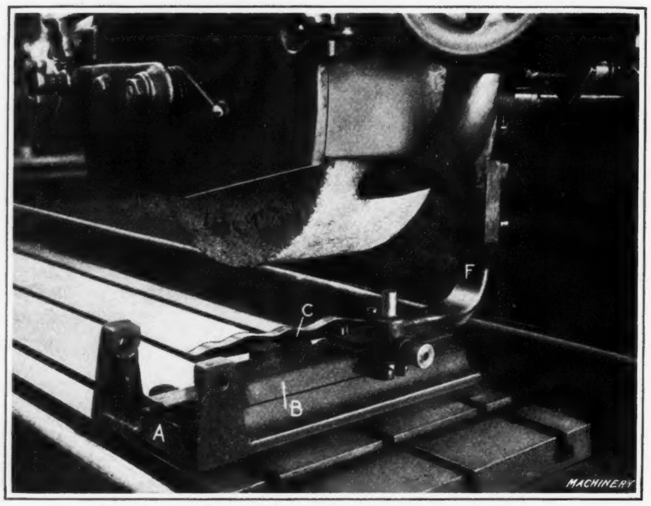


Fig. 25. Device shown in Fig. 24 partly dismantled to show Construction

the wheel either to straight or irregular form, depending on the shape of the guiding cam used. It consists principally of a bracket A held to the table of the surface grinding machine. This bracket is machined on its top surface to provide for an angular way, on which is fitted slide B that, in turn, carries cam C which operates plate D carrying diamond holder E. Slide B is operated by arm F, which it will be noticed is attached to the wheel-slide and consequently moves with it. As slide B is operated back and forth, cam C moves plate D up and down, thus raising and lowering the diamond in accordance with the shape of the cam. By simply changing the shape of the cam, this device can be used for truing the wheel to various shapes.

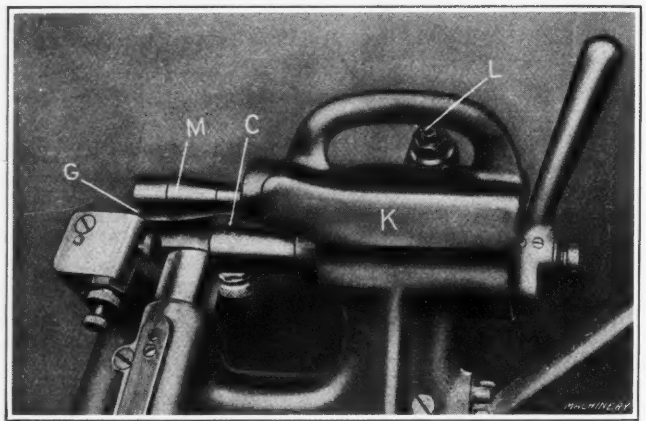


Fig. 26. Attachment used in connection with Wheel Truing Device shown in Figs. 27 and 28 for setting Diamond Tools

Attachment for Truing Wheel for Grinding Spline Shafts

An interesting attachment used on a Bath No. 20 multiple keyshaft grinding machine for truing the grinding wheel both to a radius and a bevel on the sides is shown in Figs. 27 and 28. This attachment consists of a bracket A fastened to the grinding machine table, and carrying three diamond holders, one of which is used for truing the radius, as shown in Fig. 27, and the other two for truing the bevel on the sides, as shown in Fig. 28. Referring to Fig. 27, it will be seen that the spindle B carries a diamond holder C which is set to give the desired radius by an adjusting screw. Spindle B is rotated by means of lever D, and in this way the curved surface is formed.

For truing the angular surfaces on the wheel, two separate holders E and F are used, as shown in Fig. 28. These holders carry separate diamond holders G and H which are adjusted by means of a screw and lock-nut as shown. These two holders are operated independently and alternately by means of a spindle, to which handle I carrying a cam is attached. The holders are kept down constantly in contact with the cam by means of springs, and as the handle is moved in first one direction and then the other, it operates the diamond holders. In this way, both sides of the wheel are trued in the proper relation to each other.

It is evident from the foregoing that diamond holders G and H must bear the same relation to each other, and also that some means must be provided for setting the diamond for truing the circular portion of the wheel. The device used for this purpose is shown in Fig. 26. As is shown in Figs. 27 and 28, the top face of bracket A is machined to form a dovetail slide and is adapted to receive the additional attachment K shown in Fig. 26. This is simply slipped over the top of the fixture and clamped in place by means of bolt L. A plug gage M provided with two diameters is used for setting the diamond points. In setting diamond holder C, the diamond is brought in contact with the smallest diameter of the plug, whereas for setting holders G and H, the diamonds are brought in contact with the largest diameter of the plug. With this device it is possible to secure very accurate work.

There is a large variety of devices and attachments used for truing grinding wheels for various purposes, but those given represent typical designs and illustrate principles of comparatively wide application.

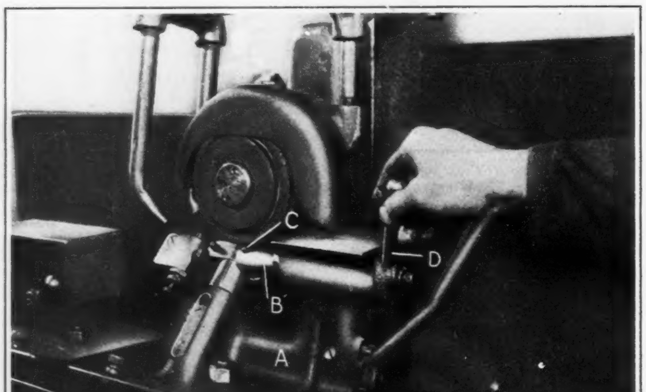


Fig. 27. Device for truing Face and Sides of Grinding Wheel for Keyshaft Grinding on Bath Machine—Device set for truing Radius

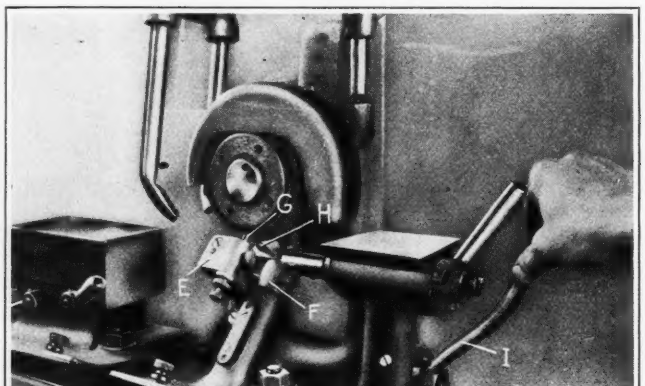


Fig. 28. Wheel Truing Device shown in Fig. 27 set for truing Sides of Grinding Wheel

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

WHAT WOULD HAVE HAPPENED IF THERE HAD BEEN NO GUARDS?

The illustrations show two accidents that occurred in the grinding department of the Pierce-Arrow Motor Car Co. and that would undoubtedly have had fatal results if the wheels had not been so effectively guarded. Figs. 2 and 4 show the guards thrown back to reveal the fractures and Figs. 1 and 3 show the guards in place. In the second case, no one was hurt and in the first case the operator was only slightly injured by the fragment of the wheel *A* that broke off. The guards probably were the means of saving his life. It is a significant fact that these two cases are the first instances in the history of the concern of a solid wheel breaking in the grinding department and yet they occurred within a week of each other. This shows how essential it is to guard all solid wheels and to make sure that the guards provided are in place and not swung back, at all times. If for any reason a guard is to be swung out to make repairs or change the wheel, it should be replaced without fail before starting the machine. Every operator should observe this precaution not only to insure his own safety but for the protection of those around him as well.

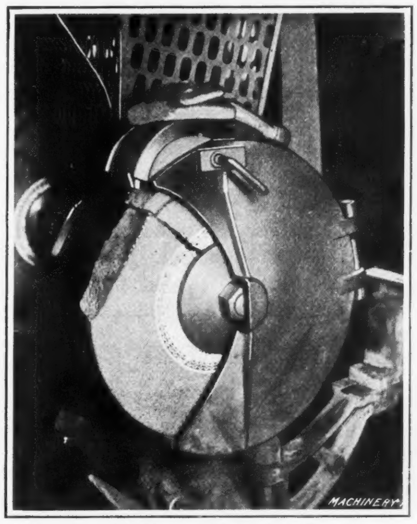


Fig. 1. Grinding Wheel that burst and Guards that prevented Serious Injury

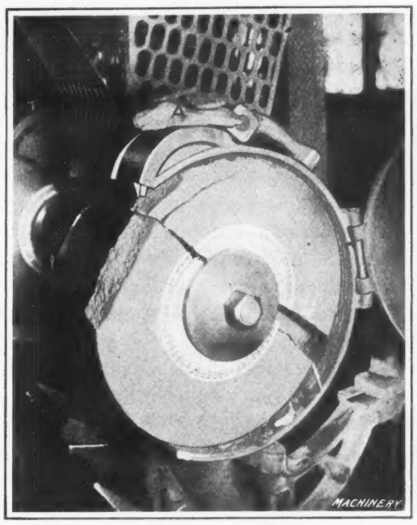


Fig. 2. Guards thrown back to show Fractures in Wheel

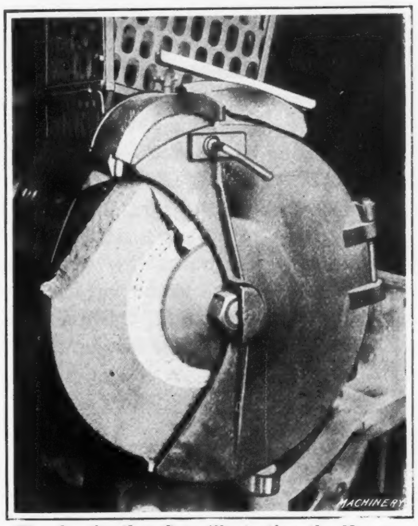


Fig. 3. Another Case illustrating the Necessity of guarding Grinding Wheels

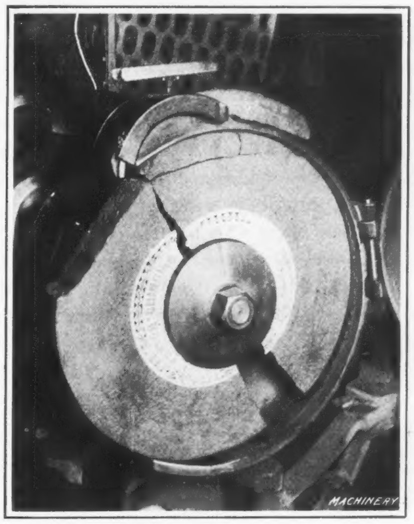


Fig. 4. Wheel shown in Fig. 3 with Guards thrown back

These wheels were 20 inches in diameter, 2½ inches face, grade 30 P. It will be noted that the fractures in the two wheels are almost identical. The cause of the rupture is a question. The grinding lathes were in good condition and the operators were careful and experienced workmen. The speed employed was only 5800 surface feet which was well within the 6000 feet surface speed allowed. Before leaving the manufacturers all wheels had been tested at a 50 per cent greater speed than maximum, and when received they had been subjected to the ring test to detect any possible injury in shipment. These tests failed to disclose any flaw in the wheels. The foregoing facts illustrate how vital a matter it is to guard all grinding wheels even when the chances of accident seem very slight.

Kenmore, N. Y. GEORGE B. MORRIS

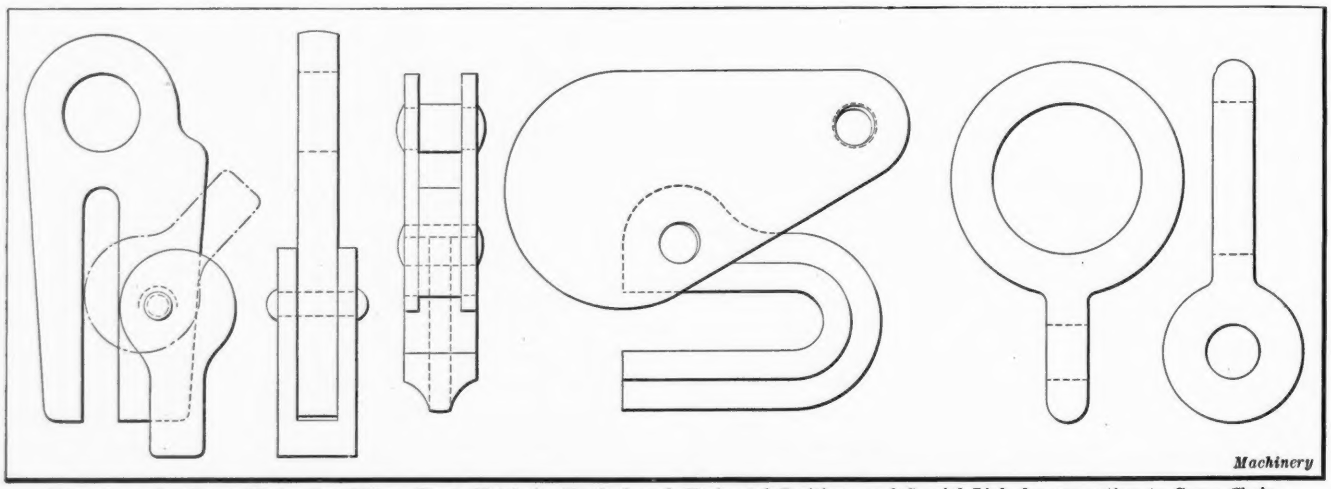
[An article givng dimensions for grinding wheel safety devices was published in MACHINERY, February, 1915.—EDITOR.]

SHORT-PAID POSTAGE

For twenty-five years the subject of short-paid postage on foreign letters has been discussed, and our consuls abroad have repeatedly called attention to the fact that it is a cause of much dissatisfaction and of injury to our foreign trade. Of course, no one believes that postage is short-paid on letters going abroad because those who pay the postage wish it to be so. It happens because the people who send these letters out think they have no control over it, and they cannot cure the difficulty. There is evidence tending to prove that they really cannot, and I know of one instance in which a foreign correspondent protested strongly against the receipt of so many letters from an American machinery manufacturer on which the recipient had to pay double postage. He received a reply apologizing and assuring him that steps had been taken to prevent his receiving any more letters on which postage was not fully prepaid, and that identical letter was short-paid, and the recipient had to pay a penalty for the privilege of reading it.

Anyone who knows something of American business office methods can easily find out what is generally the reason for short-paid postage to foreign countries. Large numbers of letters are dictated, mostly late in the afternoon, the dictator signs them hastily and gets away, leaving the stenographer and the office boy to get the mail off before going home. It is often pretty late before they get away and there is every incentive to get the work off their hands as rapidly as possible. It is hopeless to expect an office boy to read addresses, look up the amount required for foreign countries in case he has foreign letters, and put on foreign postage. In many cases, perhaps, he has no stamps for foreign postage, and the simplest thing for him to do is to put on a two-cent stamp for every letter, without reading addresses to find out if they are foreign or not.

When a business man receives a protest about underpaid foreign letters, he may go to the office boy and "jack him up." The office boy professes to be very sorry and promises to look after it, but we all know that he will not, and those of us



Figs. 1 to 3. Crane Hooks for lifting Sheet Metal in Vertical and Horizontal Positions, and Special Link for connecting to Crane Chain

who will face facts know that he cannot. And supposing we were to get the present office boy educated so that he will do it—we shall have a new office boy after a while and the educational process must be gone over again.

Like everything else that is done in a manufacturing establishment, this matter of mail to foreign countries needs to be studied and the method of handling adapted to the results sought. There are various ways of doing it, but one way is to have foreign letter envelopes of a distinctive color kept in a separate pigeon hole of the stenographer's desk. The stenographer when she writes an address may be supposed to be able to know whether it is foreign or not; may select the foreign envelope, which by its color, its shape, or by a black-faced figure printed on the envelope to be covered by the stamp, will notify the office boy that stamps for foreign postage must be attached. To scold or fire the office boy for under-paid foreign letters has been demonstrated to be a failure.

F. J. M.

CRANE HOOKS FOR LIFTING SHEET METAL

It is the purpose of this article to describe two forms of crane hooks which we have found useful for lifting sheet metal when held in a horizontal and in a vertical position, respectively. Fig. 1 shows the hook used for lifting a sheet held vertically, the capacity of which is for stock from 1/16 to 7/8 inch in thickness. It will be seen that this hook is simply an inverted U-shaped member with a U-shaped cam riveted to it. The solid lines show the position of the cam when the hook is being dropped into place on a sheet of metal, and the dotted lines show the position assumed by the cam while the stock is being lifted. The contact surface of the cam is serrated so that it secures a firm grip on the metal, and the heavier the load to be lifted the greater the grip secured by the cam; consequently there is no danger of the sheet being dropped.

Fig. 2 shows a useful form of hook for use in lifting sheet metal held in a horizontal position. It will be seen from the end view that this hook consists of two wrought-iron plates which are riveted together in such a manner that the U-shaped hook is supported between them. The way in which the hook is used is shown in Fig. 4, and the illustrations make the method clear without requiring more than a brief description. The hook will lift sheets up to 3/4 inch in thickness, and it will be evident that the cam-plates at each side of the hooks adjust themselves for the thickness of the stock as soon as the operator starts to raise the hoist. The cams are riveted together at the small end and a bushing is provided to keep them the required distance apart. This bushing fits through the small eye of a special link of the form shown in Fig. 3, and the rivet that holds the cam-plates together fits through the bushing. The large eye of the link receives the chain as shown in Fig. 4. Both of these hooks have been in use for some time in the shop where the writer is employed, and have given very satisfactory results.

L. K.

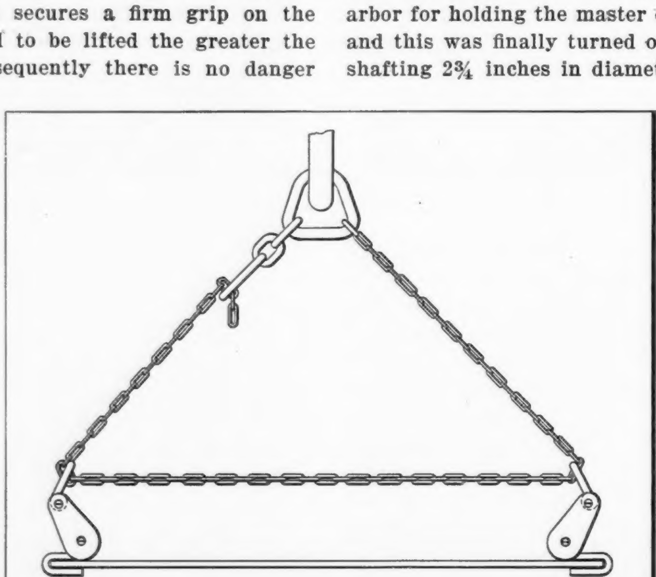
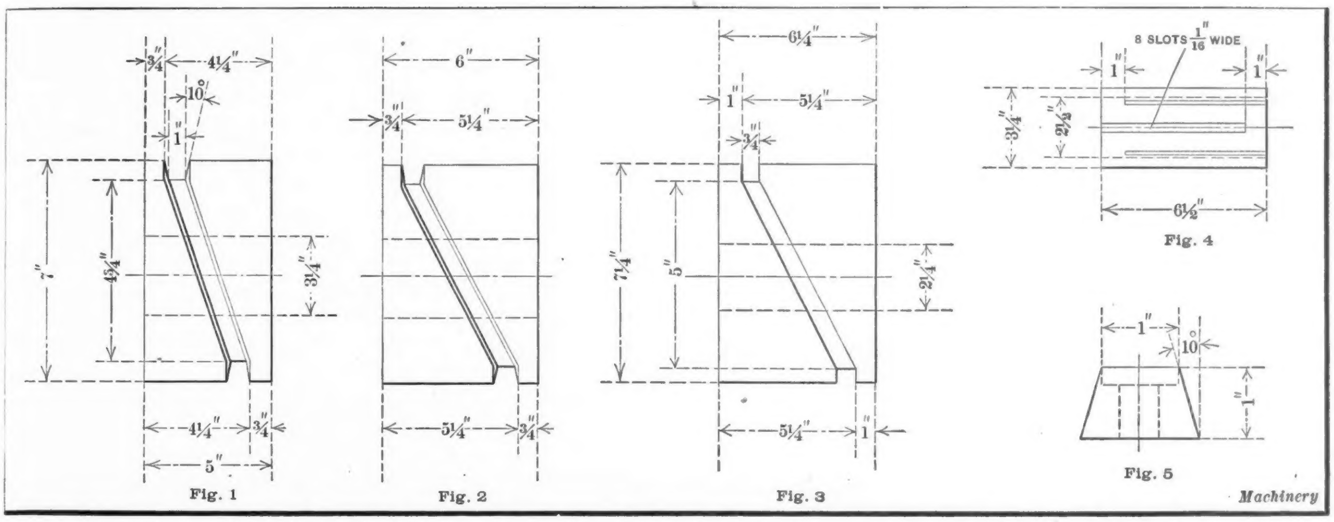


Fig. 4. Method of connecting Hook shown in Fig. 2 to Load Chain of Hoist

CUTTING BARREL CAMS ON THE LATHE

In the factory where the writer is employed there are quite a few machines on which cams are used which are of the form shown in Fig. 1. It was thought we would get better results by increasing the pitch of the cams one inch, as shown in Fig. 2, and so we asked for an estimate on the cost of new cams for the machines. The bids submitted were so high that the project was temporarily abandoned, but finally we looked the proposition over and decided we could do the work in our own shop. The method finally adopted was quite interesting, and will be readily understood from the description in the following article.

We did not employ a patternmaker, but had an intelligent carpenter who could follow rough sketches and verbal instructions. He produced a rough pattern from which we made a casting of the form shown in Fig. 3, allowing about 1/8 inch for finish. This casting was finished and used as the master cam in machining the seventeen other castings which were made from the same pattern, to be finished for use on the machines. The next problem was to make a suitable arbor for holding the master cam and the casting to be turned, and this was finally turned out from a piece of machine steel shafting 2 3/4 inches in diameter by 3 feet long. The shafting was centered and turned down to 2 1/2 inches in diameter with a taper of 0.005 inch per foot. Next we took a piece of machine steel 4 inches in diameter by 7 inches long, which had a hole 1 1/2 inch in diameter bored through it. We set this up in the lathe chuck and bored out a hole 2 1/2 inches in diameter; the piece was next put on the arbor and turned to a diameter of 3 1/4 inches on the outside, after which it was faced off to a length of 6 1/2 inches. By cutting eight slots 1/16 inch in width in this piece, a satisfactory expanding sleeve was made, as shown in Fig. 4.



Figs. 1 to 5. Original Cam, Redesigned Cam, Cam Casting, Split Bushing to hold Cam on Arbor, and Roller to engage Master Cam

For use as a master cam, we took one of the castings and filed the groove on both sides to make it fit the roller shown in Fig. 5, which is 7/8 inch in diameter. After this had been done, we set up the casting in the lathe chuck and bored out the hole to a diameter of 2 1/2 inches, and also drilled and tapped a hole 1/2 inch in diameter to receive the set-screw *H* which was used to secure the master cam to the arbor, as shown in Fig. 6. The next step was to forge a cutter to the desired shape and dimensions for machining the cam grooves; and to fasten a flat piece of machine steel to the carriage of the lathe, on which the cam roller to engage the master cam was carried by a stud.

After this preliminary work had been completed, we were ready to proceed as follows: The castings were first placed in the lathe chuck where the hole was bored out to 3 1/4 inches in diameter. One of the castings was then put on the arbor *F*, Fig. 6, where it was held in place by means of the split bushing *G*. The outside of the cam was then turned to reduce its diameter to 7 inches, after which a 1/2-inch hole was drilled and tapped in the same position as on the master cam. The master cam was now mounted on the arbor and held in place by means of the 1/2-inch set-screw *H*, and engaged by the roller *B* carried on the stud *C*, which fits into the machine steel bar *D* on the carriage, this bar being held in place by the bolts and dowel-pins *E*. The tool is fastened in the toolpost in the usual way, and the carriage is disengaged from the feed mechanism in order that it may be moved along the bed through the action of the master cam and roller.

In setting up the work there should be a difference in angle of 90 degrees, *i. e.*, when the set-screw in the master cam is over the cam roller *B*, the set-screw in the casting to be machined should be opposite the cutting tool *I*. It must be borne in mind that the metal is to be removed all around on both sides of the cam groove, and so the casting must be driven onto the arbor tight enough so that it will be held in place. When cutting the groove the tail of the lathe dog should be tightly wedged in the slot of the faceplate to prevent lost motion. After the groove in all of the cams had been machined, the master cam *A* and the strip *D* holding the cam roller *B* were removed so that the cams could be set up on the arbor to have their ends faced. After this work had been done, it was merely necessary to cut the keyway, after which the cams were ready for use.

M. H. CHASE

THE BREAKING OF A SPRINKLER HEAD

The old saying "Experience is sometimes a dear teacher" was brought home to us very forcibly the other day when an overhead belt broke and knocked off a sprinkler head in our grinding department, which resulted in the water coming down altogether too fast for comfort. Nobody seemed to know just where the shut-off valve was located, and by the time it was finally shut off some special machinery on the floor below that was almost ready for shipment became thoroughly drenched. We now have signs in every department that tell just where the shut-off and draw-off valves are located, and every foreman and assistant foreman, besides two or three reliable operators in each department, know just where the valves for their respective departments are.

SUPERINTENDENT

A SAFETY HINT TO DIEMAKERS

One of our diemakers met with a rather painful accident the other day while he was trying out a set of tools in a

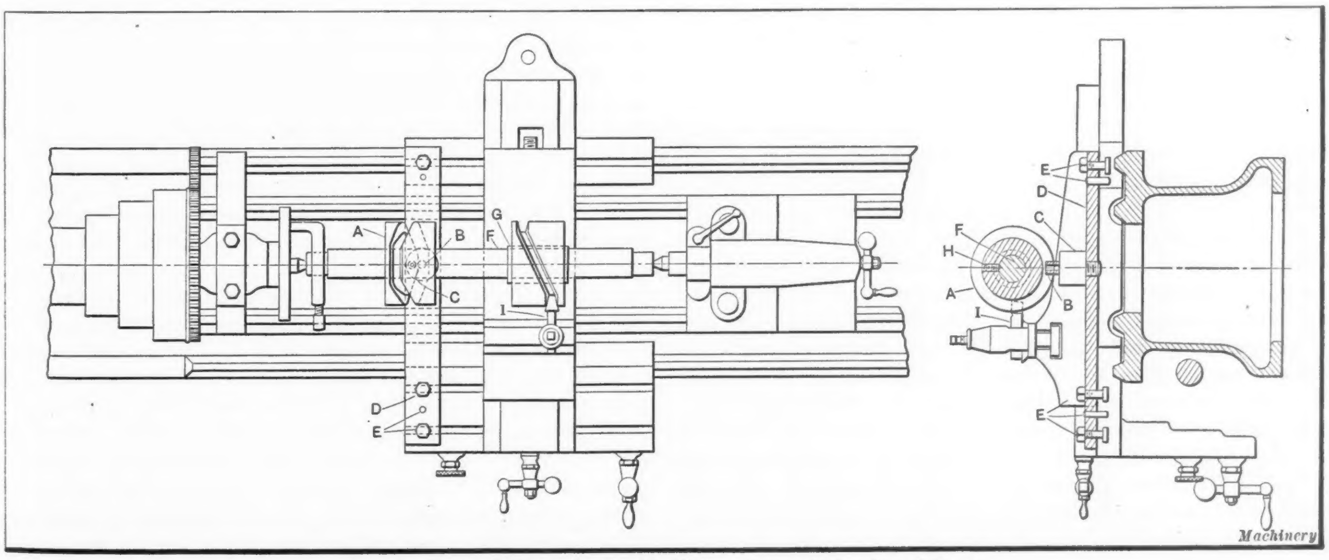


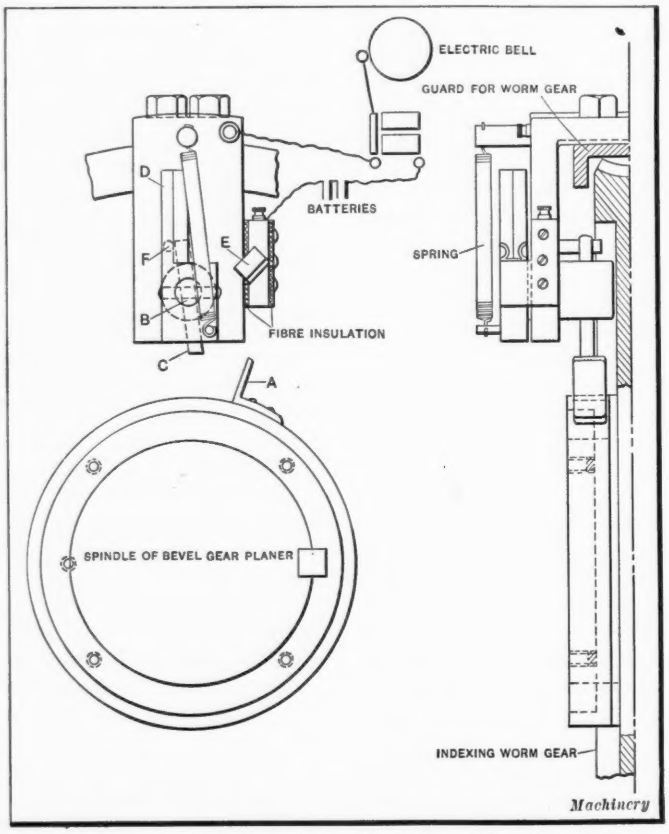
Fig. 6. Engine Lathe equipped with Fixture for machining Barrel Cams

power press. He had the belt off, but had brought the gate of the press one-quarter of the way down. While placing the punch in position, which he tried to do by holding the punch in his left hand (something every diemaker has done), the gate suddenly descended of its own accord, due to a loose friction. The result was a badly squeezed hand which required several weeks of rest and treatment. If the press had been larger, the accident would have been more serious. It hardly seems necessary to say that our diemakers now see to it that the gate of the press is up before fastening the punch in position.

SAFETY FIRST

ELECTRIC ALARM FOR BEVEL GEAR GENERATOR

In the operation of a Gleason bevel gear generator, it is necessary for the attendant to stop the machine after the last tooth has been completed; and if he fails to do so the tools will start taking a light cut over the finished teeth, making them under size. When one operator is running four or five machines, it is difficult for him to always be on hand at exactly the time when each machine has finished cutting its gear, and to avoid having the machine run over, the operator is likely to wait for the last five or six teeth to be cut rather than run the risk of spoiling the work. To avoid the trouble which we had experienced from this source, the writer designed an electric alarm system, which is shown in the accompanying illustration, and applied an outfit of this kind to each of the bevel gear generators, with the result that the only objection which we had to an otherwise excellent machine has been overcome. Not only does the alarm prevent spoiling any of the work, but it also increases production, as the time spent by the operator in waiting for the machine to finish the job is cut down to a minimum.



Electric Alarm for Gleason Bevel Gear Generator, which notifies Operator that Gear is finished

By referring to the accompanying illustration, it will be seen that two concentric rings are mounted at the rear end of the spindle behind the indexing worm-wheel. The inner ring is fastened to the spindle by means of a key and set-screw, and this ring carries four set-screws for holding the outer ring in any desired position relative to the spindle. The outer ring carries an adjustable trip-block A, the position of which can be adjusted with respect to the spindle; and when the correct adjustment has been obtained for a given set-up, the position of the trip-block need not be changed until a new set-up is made. A piece of ½ by 2-inch flat cold-rolled steel was bent to the form shown, and fastened to the worm-gear guard by means of cap-screws; and the contact mechanism was carried on this bracket. A shoulder pin B carries the trip-pin C which is located at the rear side of the bracket, and the shoulder pin passes through the bracket and carries the contact block D. The contact block is beveled as shown in the illustration, and when tripped will make contact with the copper spring contact E which is mounted at an angle on a piece of cold-rolled steel separated from the supporting bracket by fiber insulation. Electric wires run from the bracket and contact block to the batteries and electric alarm bell.

In the normal or "non-ringing" position, the upper end of the trip-pin C rests against a stop-pin F and is held in position by a spring. As the gear is indexed, the adjustable trip-block A rotates, and as soon as the work is finished the trip-block comes into contact with the trip-pin C and pushes it past the center point. When this happens the spring acts on the opposite side of the center line and snaps the contact block D down against the copper spring contact E. This closes the circuit and the bell rings until the operator raises the contact block to the normal position. The alarm is then ready to start ringing again after another gear has been completed.

Rockford, Ill. E. K. MORGAN

"WHAT'S THE MATTER WITH THE FOUNDRIES?"

We note the article written by Mr. Brophy in the October number of MACHINERY in which he criticises the foundries and wants to know what is the matter with them. May it not be possible that the fault lies with the users of the castings? Is it not a fact that in the large majority of cases the patterns are made without consulting the foundry? The designer produces a machine; then we hunt for some way to core the patterns with the least trouble to ourselves and the foundry. To illustrate, a shaper table may have an opening in one side only. The natural position for the core to rest in would be the bottom of the drag, but this brings the dirt in the mold if there is any, next to a finished surface of the casting. If the core were hung on the side of the mold by means of an arbor the finished portion of the casting could be placed in the drag. Similar instances of this sort are usually brought to our attention by the foundries after the patterns are made, and sometimes they are acted upon but usually not. We always condemn the foundries first because that is the easiest place to lay the blame.

Would it not be better to pay a little more for our castings to enable the foundries to rig up properly to make them? Is it not a fact that we spend much time and money in laying out and carrying through each operation of building our machines? When it comes to the foundry we expect it to do what we admit is a very difficult job, with a stick, a string and a rag. What foundry has been successful that has attempted to employ all the modern means in competition with the lower grade foundries? The lower grade foundry simply passes the responsibility and the expense of its operations along to the casting users.

Do the casting users in their dealings with the foundries see to it that the foundry has chemists, laboratories, means for drying all molds, several cupolas, inspectors and the proper material before closing a contract? Would the casting users pay the price? The usual question is, at how low a price per pound can we get the castings. If the price given is not as low as others quote, then the patterns are transferred to another foundry quoting a lower price—where new flasks have to be made and the work has to be experimented with before proper results are obtained. The flasks and rig-

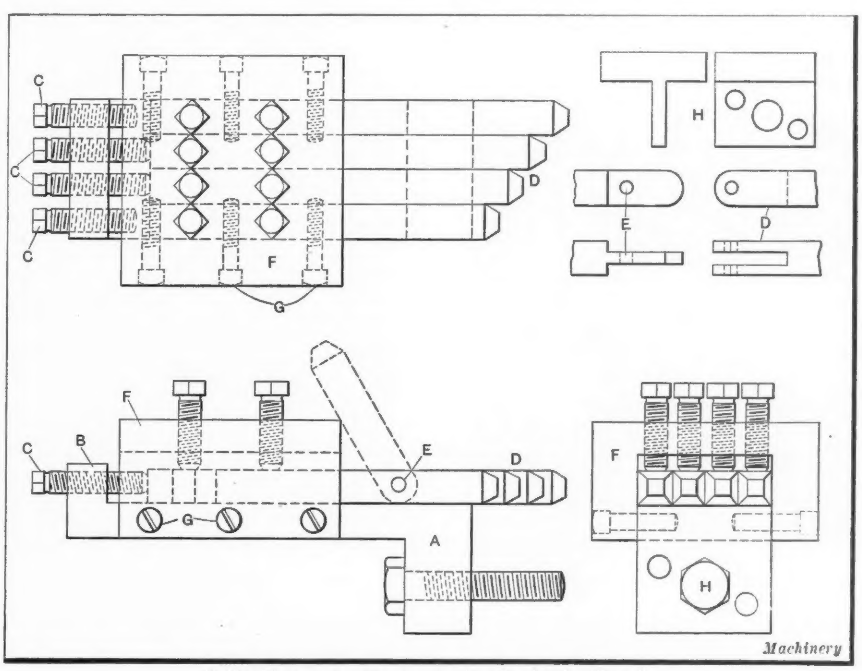
ging are made as cheap as possible because it is not known how long the job is going to stay, and the risk of preparing for it properly cannot be taken. (We have been getting castings from the same foundry for eleven years.) Those concerns operating their own foundries cannot show a heavier operating expense than those of the outside foundries, because the casting user will not give the foundry credit for the better product.

The fault with the foundries seems to lie with the casting users, as they are satisfied to accept castings and take chances that they will be all right, or if bad that the expense of correcting them will not be as much as the additional price that must be paid if all the improvements of modern foundries are used. N. B. CHACE, Supt.,

Cincinnati, Ohio. Cincinnati Shaper Co.

MULTIPLE THREAD CHASING FIXTURE

The lathe fixture which is illustrated and described herewith was originally designed for use in chasing the quadruple threads of brass worms, but like many other tools of a similar nature its original purpose has been lost sight of. At the present time it is being used for a variety of multiple thread chasing operations, and is giving very satisfactory results. In the design of this attachment there were two primary requirements to be fulfilled. First, to relieve the mechanic of the tedious and sometimes perplexing task of advancing the carriage for taking a fresh cut by disconnecting the gears; second to overcome the difficulty sometimes experienced where a piece of work is left unfinished for the night and the operator forgets how far he had progressed toward the completion of his work.



Lathe Fixture for Use in chasing Quadruple Threads

This fixture is not intended to be used as a standard equipment for each lathe; the purpose is to have it on hand in the tool-room so that it can be adjusted by one of the tool-makers and checked out, leaving the lathe-hand nothing to do but attach it to the carriage of his machine. In some shops, and especially in shops handling experimental work, the provision of two of these fixtures—one for small and one for large sized standard lathes—would satisfy all the requirements that are likely to be met. It will be well to have several lathes of each size provided with holes which are tapped and reamed to receive the fastening screw and taper dowel pins, as there will then be no trouble in finding a machine for use in handling a rush order.

The body *A* of the fixture is made of cast iron and the anchoring lug and lug *B* for the adjusting screws *C* are made in a single piece, the length of which is such that when the fixture is set up ready for use the shortest of the stop-pins *D* will be nearly flush with the square end of the body of the fixture. It will be seen that the stop-pins *D* are pivoted at *E* so that they may be swung up out of the way. The housing *F* is also made of cast iron and fastened to the body *A* by six fillister-head screws *G*. The adjustable stop-pins *D* are made of machine steel and beveled on the contact ends, while the adjusting screws *C* should be of fine pitch to facilitate making very fine settings of the stop-pins.

In laying out the holes in the fixture and in the cross-slide of the carriage, the opposed templet *H* was found useful; one face of this templet was marked "carriage" and the other face was marked "fixture". The fixture should be attached to the lathe so that the contact pins *D* clear the top of the cross-slide to enable the compound rest to be swung through an angle of 90 degrees. After the chasing tool has been set in position for taking the cut, the slide is brought up to the first stop *D*—using a tissue paper feeler to prevent jamming—and one of the threads is cut. The stop which locates for this thread is now raised, as shown by the dotted lines, and the slide is brought up to engage the second stop for cutting the second thread. This process is repeated until all the threads have been cut. The cost of this fixture is slight when its value is taken into consideration, and it will be found a great saver of trouble when cutting multiple threads.

Stillwater, Minn. R. C. MACLACHLAN

FLASHBACK IN THE WELDING TORCH

I read with much interest the article on "Flashback in the Welding Torch" by M. K. Dunham in the September number of MACHINERY. It would have been interesting if Mr. Dunham had given the difference in principle of the two welding torches used on the two large gears, and shown the principle used in a correctly designed torch.

While the writer has not experimented with very many torches, he has never seen one that on heavy hot work will not flash back if the temperature of the head and tip is allowed to become high enough. This is most likely to occur in deep welds where it is difficult, if not impossible, for the welding flame to get away from the head and tip, thus heating it more rapidly than when the same weld becomes shallower. Upon cooling the head and tip, flashing back will not occur until they again become heated to a high temperature, and I question if it is possible to avoid flashing back under such conditions. The use of water-cooled torches for such work is common and these torches do not flash back, although they may back-fire due to the end of the tip touching something and thereby momentarily reducing the velocity of the gases as explained by Mr. Dunham. This, however, is not caused by the design of the torch, as is very clearly explained in Mr. Dunham's article.

The only serious trouble that the writer has ever experienced with flashing back is, as explained above, in the case of heavy deep welds. The same torch with the same tip and the same operator will not flash back in welds of lighter section. Therefore the cause for such flashbacks must lie in the overheating of the head and tip, and would appear to be due to the burning of the acetylene inside the tip, caused by the excessive heat. In other words, the acetylene is ignited before it gets to the tip. There is no question about the expense or danger and annoyance caused by flashing back. Mr. Dunham has covered these points very clearly and forcibly.

I also want to add my word of accordance with Mr. Dunham in his stand against the too common practice of manufacturing and selling oxy-acetylene welding apparatus that is unec-

onomical, wrong in theory and unsatisfactory in practice. Anyone who really has the interests of the oxy-acetylene welding industry at heart will condemn such practices.

There are, however, one or two points in his article that I do not understand. The statement is made that an injector torch should not be used with dissolved acetylene for the reason that it does not take advantage of the available pressure to avoid flashbacks, while it is exactly what is required for a low-pressure generator. It is also stated that for the same reason the medium-pressure torch should not be used with dissolved acetylene. It does not appear to me that the reasons assigned are sufficient to make the use of either of these torches with dissolved acetylene undesirable. The regulating valves provided for use on tanks containing acetylene under pressure will furnish the required low pressure and medium pressure, respectively, if used on the two types of torches mentioned, and if a torch of any design is economical at the pressure for which it is designed and is used at that pressure, I fail to see what the storage pressure of the acetylene has to do with the operation of the torch. The whole question of torch economy and performance is one that is in great need of scientific investigation. The most economical type of torch has probably not yet been developed. At any rate, the writer does not believe that anything whatever is accurately known as to the pressure conditions under which any torch operates. The pressure on the gage as ordinarily used is no criterion of that in the torch. The heating of the head in heavy welding, the unavoidable commercial variation in the sizes of the passages in the torch and tip, the irregularities in different gages and regulating valves, and many other things, all combine to cause serious discrepancies in the performance of torches.

The writer believes that there is no accurate information in regard to the relative proportions of oxygen and acetylene in any torch, on account of the difficulty of measuring the quantities of gas consumed, particularly in the case of acetylene. It is admitted without argument that the best torch manufacturers have succeeded in producing apparatus which gives remarkably good results, but it has been done largely by cut-and-try methods, which, of course, directed by intelligence and skill, will continually produce better results. However, the writer believes that the time is nearly here, if indeed it has not already arrived, when something more is necessary, and he feels that investigations must now be made with the most accurate apparatus available and under the most stringent conditions, so that having as nearly as possible absolute knowledge of the facts, the effect of any variation from the correct principle and practice may be determined. This involves the control of conditions so that any number of tests can be made and results duplicated within the limits of errors of observation. This in itself is no mean task. As just one illustration, it has never been determined, to the writer's knowledge, what a neutral flame is, although it is talked about familiarly and frequently as if it were something very readily obtained. There are reasons, however, for questioning if it is possible to produce a neutral flame, or at least to determine the neutrality by the eye alone. According to the writer's estimate, there are twelve vitally important things which will have to be investigated, in addition to many more minor conditions. It will be readily seen that the subject is one of vast extent and one which will require the best efforts of those interested in the matter for a long period of time.

In conclusion, these statements are not made with the view of discouraging experimenting, but to show the importance and necessity of using only the best available apparatus, which is that manufactured by concerns who have the greatest knowledge of the facts, the best facilities for testing and who are the soundest financially.

Rochester, N. Y. S. W. MILLER

SAFETY DEVICE FOR HANDLING WORK ON THE CIRCULAR SAW

Fig. 1 illustrates a common cause of serious accidents in the patternshop. It will be noticed that the operator has placed a straight piece of wood *A* between the work and the saw guide to get the correct distance in making cuts for lap. The distance piece *A*, having nothing to hold it, slipped back in moving the work across the saw, causing the bracket to fly out and bind on the saw. This resulted in the saw's kicking back, knocking the operator's hand down onto the revolving teeth, and cutting his fingers. The man was fortunate not to lose his fingers entirely. At *B* in Fig. 1 is shown a piece

Fig. 1. Dangerous Method of spacing Saw Cuts with Circular Saws

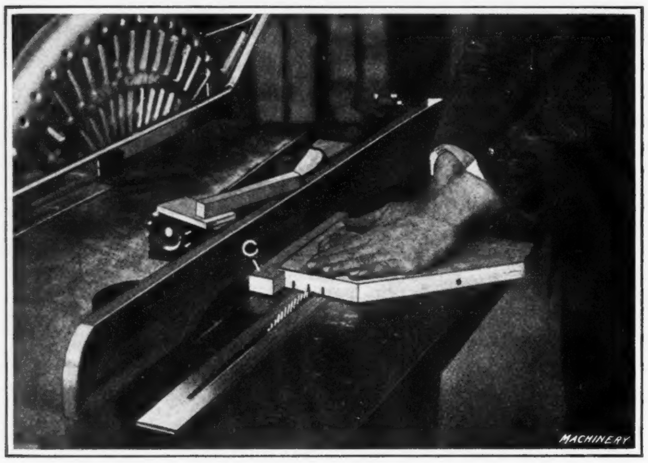


Fig. 2. Gaging Strip that eliminates Danger of Work slipping

that was made to prevent the recurrence of such an accident. In Fig. 2 this piece is shown in use at *C*. It will be noted that it is made with an enlarged end which fits around the corner of the bracket and does away with the possibility of slipping. It takes only a few minutes to make this piece and the operation is made much safer by its use. In this case, it was impossible to use the regular metal guard provided.

Kenmore, N. Y. GEORGE B. MORRIS

MEETING THE EMPLOYE HALF WAY—A CHALMERS PRINCIPLE

One of the most important lessons now being mastered by the captains of modern industry is the necessity for conserving health and contentment among employes. An intricate machine will not work efficiently without intelligent care. A trained worker is the most valuable asset of the manufacturer. Forgetting the humanitarian side entirely, he cannot afford, economically, to permit his employe to work amid surroundings detrimental to mind and body. The most significant index to this fact is the stringent legislation against long working hours. "Safety First" is a slogan that has brought widespread reforms in factory precautionary equipment in the past two years. Those companies which have recognized the importance and need for the awakening have progressed rapidly. Now they are being heralded, not only as philanthropists, but as far-sighted business captains as well.

An inviting factory site is just as important as a roomy and hygienic interior. If the workman trudges up a dirty cinder path every morning, entering forbidding prisonlike walls that shut him off from the out-of-doors, his mind is likely to be hostile from the beginning of his day's work. If, on the other hand, everything is done to make his surroundings attractive, his attitude toward his employer will be more kindly. When plans were made for the erection of the Chalmers plant, Hugh Chalmers selected a spot far away from the factory centers of Detroit. At that time the grounds of his choice were almost in the country. Thirty-two acres of ground were plotted out and work begun. The buildings, which are a combination of the unit and group types, are of reinforced concrete and are distributed so as to afford the maximum of light and air. The four main buildings are each four stories high.

Sanitary drinking fountains are conveniently located throughout the works and offices. The water is cooled at some points by earth coolers, thirty feet deep, and at others by ice-cooled coils. In the departments where men are exposed to great heat, as in the heat-treating department and the power house, shower baths are provided. A large and well equipped "serveself" restaurant is maintained in a building especially erected on the Chalmers grounds. At a minimum cost the employes can get good wholesome food. Eighteen or twenty cents will buy a hearty meal for a hungry laborer. A modernly equipped hospital with a graduate surgeon in constant attendance is maintained on the grounds. In the case of injury to any employe, the patient is at once taken to the doctor's office and such first-aid administered as is necessary. A factory ambulance is ready to take any one seriously injured to a hospital.

Before any employe is hired he is given a thorough physical examination. If he is afflicted with any contagious disease that would be a menace to other employes he is not admitted. If, however, he is found to be suffering from a slight affliction that does not destroy his capability for work he will be given the employment that he can do best under his handicap. For instance, if a man's eyesight is subnormal he will be assigned to tasks where eye-strain will be least likely to develop. If weak lungs show under the physician's examination, out-of-door work will fall to his lot.

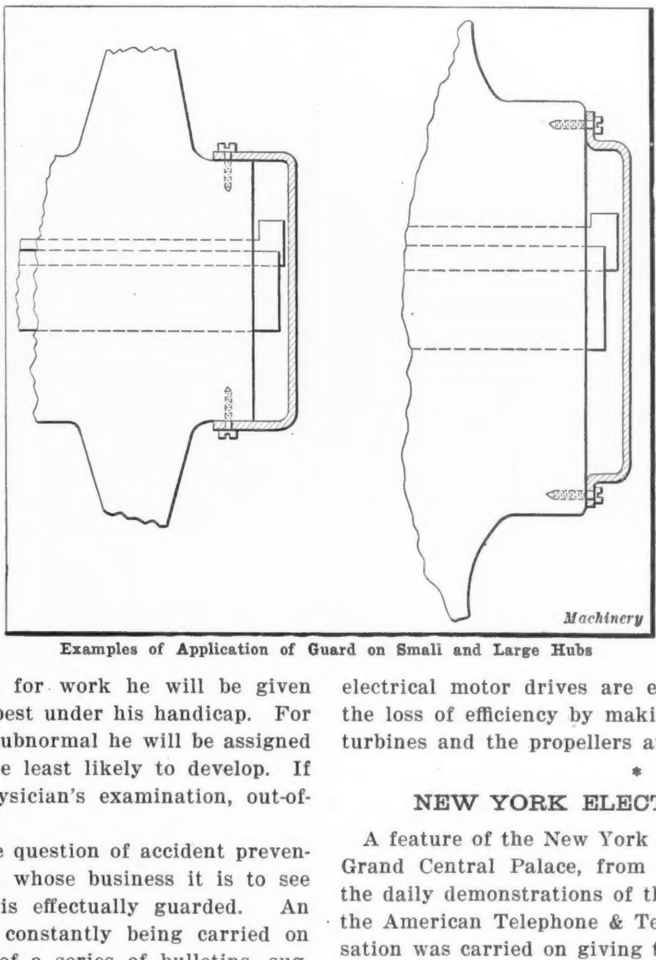
Special attention is paid to the question of accident prevention. Inspectors are maintained whose business it is to see that every dangerous machine is effectually guarded. An educational safety campaign is constantly being carried on among the employes by means of a series of bulletins, suggestions and instructions posted on "Safety First" bulletin boards.

One of the most inviting features of the Chalmers plant is the landscape gardening. Spacious lawns, bordered with shrubbery and flowering plants are tastefully laid out. Instead of the cinder heap and the slag pile, green grass and stately maples meet the eye. A regulation tennis court and a ball diamond have been provided for the noon-hour entertainment of the employes.

Detroit, Mich. OWEN B. WINTERS

GUARDING THE HEADS OF GIB KEYS

Gib keys of the kind commonly used in the flywheels of blanking presses and other machines where the shaft runs continuously, are likely to cause accidents when the machines are located near passageways, by the head of the key catching the clothing of someone passing by. The accompanying illustration shows a simple form of guard which is in quite general use for eliminating this hazard in machine shops. It consists of a metal shell fastened to the hub of the flywheel, and the illustration makes the idea quite clear without requiring further description. Two methods of fastening the shell to hubs of different sizes are shown. The advantages of this guard are simplicity and low cost combined with absolute protection. SAFETY FIRST



Examples of Application of Guard on Small and Large Hubs

* * *

ELECTRICALLY-PROPELLED BATTLESHIP "CALIFORNIA"

The keel of the dreadnaught *California*, the first electrically-propelled battleship, was laid in Brooklyn Navy Yard, October 14. The new addition to the navy will have a length of 624 feet; width, 97 feet, 4½ inches; draft, 30 feet; displacement, 32,000 tons; speed, 21 knots and an armament of twelve 14-inch guns in four turrets, a secondary battery of twenty-two 5-inch rapid-fire guns and four submerged tubes capable of firing the largest types of torpedoes. The cost of the vessel complete will be about $15,000,000. The *California's* electrical drive is the result of experience gained by the U. S. Navy with the collier *Jupiter*, a vessel of 20,000 tons displacement. The especial advantage of the electrical drive is that the steam turbines may be run at high speed while the propellers are run at a slower speed best suited to their diameter and pitch. The drawback to all direct-connected turbine drives is that the steam turbines must either be run at an inefficient speed to accommodate the propellers or they must be made of enormous size. The designer compromises between the two extremes with the result that neither the steam turbines nor the propellers are worked at their best efficiency. Mechanical reduction gears or electrical motor drives are expedients designed to eliminate the loss of efficiency by making possible the operation of the turbines and the propellers at their most efficient speeds.

* * *

NEW YORK ELECTRICAL EXPOSITION

A feature of the New York electrical exposition, held in the Grand Central Palace, from October 6 to 16 inclusive, was the daily demonstrations of the transcontinental telephone by the American Telephone & Telegraph Co. Telephonic conversation was carried on giving the news of the day and happenings at the Panama-Pacific Exposition. Other features that made the demonstration of striking interest were the transmission of music and the roar of the Pacific surf.

The exhibit as a whole demonstrated some of the many uses to which electricity is being put in the home and factory. The progress in electrical lighting was strikingly demonstrated by comparison of the modern lamps with the early carbon lamps. An exhibit made by the U. S. Government included the first Blanchard gun-stock turning lathe built in 1822 and a modern gun-stock turning lathe embodying the same principles. A gun barrel rifling machine was also shown.

* * *

German silver that is to be used for machined castings should contain from 2 to 3 per cent lead, as this makes it easier to machine. The lead content increases the whiteness of the alloy.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PRODUCING CHEAP BRASS AND COPPER STAMPINGS

D. L. A.—As manufacturers of medals, name-plates, etc., we are trying to find a metal suitable for making impressions, to be used with embossing dies in producing cheap metal stampings of brass and copper in about 20 to 24 gage metal. We have been using steel forces for doing this work, but find it expensive. We have heard that there is a metal especially employed for this purpose abroad. This metal, we understand, is similar to bronze and is first struck up into the dies and repeatedly struck until it cools, as there is practically no shrinkage, and the metal is nearly as hard as hardened steel. Any information relating to this metal, or to any other method for doing the work in a less expensive way, will be appreciated.

This question is submitted to our readers for comment.

PROPER SURFACE FOR HARDENING

W. S. R.—A subject that has been of interest to the writer and some of his toolmaking friends is: What is the proper surface to give steel tools that are to be hardened and ground? A difference of opinion exists as to the relative merits of a smooth surface almost polished and a surface left by a lathe or shaper tool when it is said to be cutting smoothly. If the smoother surface is not of any advantage it should not be produced, as it represents wasted time. Some toolmakers claim that a polished surface is a positive disadvantage in securing uniform hardening.

A.—The general impression seems to be that tools harden best when the surface is true but not smooth. A polished condition is disadvantageous, as steam bubbles collect in larger masses and tend to produce uneven hardening. The experiences of readers in regard to the best condition of steel for hardening are solicited.

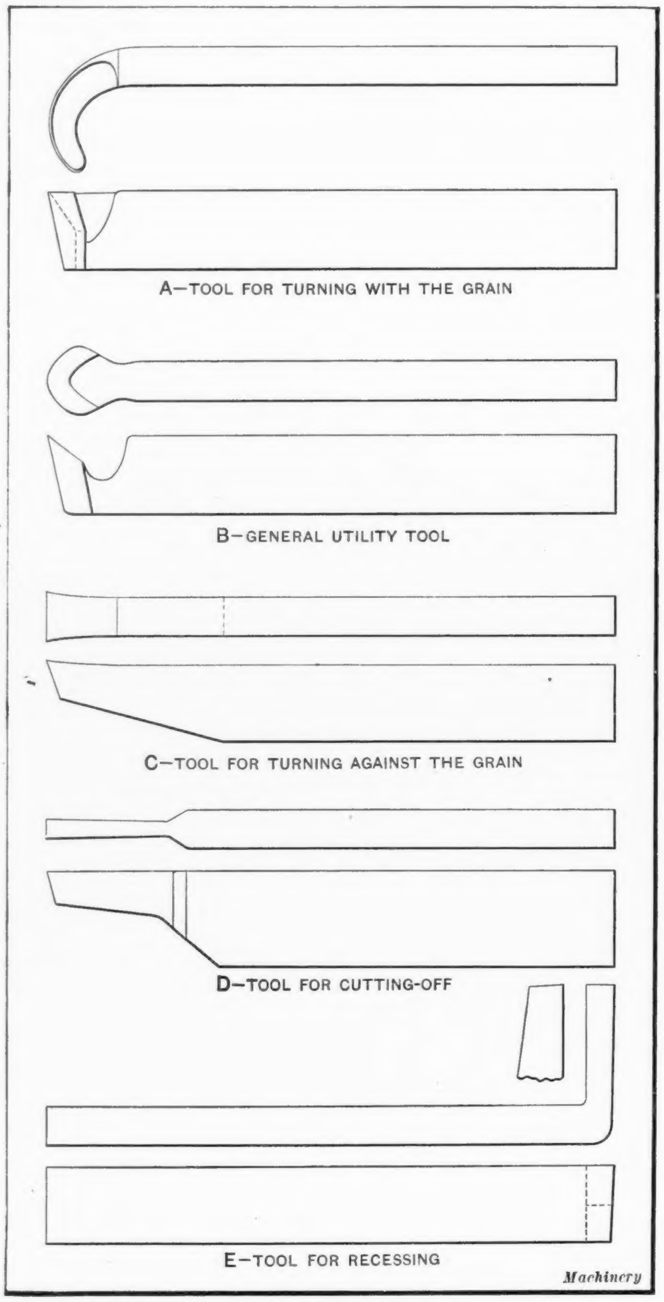
DEEP-HOLE DRILLING

H. A. D.—Will you explain why a more accurate hole can be drilled in a gun barrel by rotating the barrel than by rotating the drill? Why will not the drill produce as straight a hole when rotated as when held stationary and the work rotated?

A.—The basic principle of deep-hole drilling is that of developing an axis of rotation in the part to be drilled and making the drill follow this axis. When a gun barrel is drilled it is held firmly in a chuck at one end and in a bushing at the other. Thus an axis of rotation is developed which is a geometrically straight line connecting the two supports and coinciding with the center line of the barrel. The drill is started at one end of this axis, and as it is forced through the barrel it tends to follow the axial line, as that is the course of least resistance and the direction in which it is guided; any deviation from the axial course deflects the drill and thus causes it to meet with more resistance. If the drill were rotated while the work stood still no axis of rotation would be developed in the larger and stiffer work-piece, and while the drill would in a general way tend to cut a hole in line with its axis, the hole would not be straight because of insufficient support for the drill and the difficulty of starting it dead in line with the axis of the work-spindle and work-piece. Any deviation no matter how slight would deflect the drill axis from the axis of the hole that should be drilled and as the drilling proceeded the deflection would tend to become greater and greater. The result in drilling a hole thirty inches or more in length is that it would surely vary considerably from the true axis of the barrel and besides be crooked. Rotating the work develops a geometrically straight path which the drill tends to follow, whereas rotating the drill and letting the work stand stationary develops no path and hence has no guiding tendency.

TOOLS FOR TURNING WOOD

E. B. E.—We wish to get some information on tools for wood turning. We are not conducting a wood-working shop, but occasionally have to turn up a piece for a base for apparatus and at times have a little cylindrical pattern work to do. We are especially desirous of learning what are the ordinary shapes used for turning wood both with and against the grain.



Shapes of Wood-turning Tools

A.—Your question can best be answered by illustrating somes of the types of wood-turning tools most commonly used. The tool illustrated at *A* is hook-shaped with the cutting edge sharply relieved for the entire distance of the sweep or curve. This tool is used principally for rough-turning parallel with the grain, and can be fed in either direction. Another general utility tool is illustrated at *B*, and this is used either with or against the grain, and from its shape it will be seen that it can be fed in either direction. The tool illustrated at *C* is used for turning against the grain and can be used in either direction and also as a facing tool. The tool shown at *D* is a typical cutting-off tool. This is relieved for about half its depth on the under side as no particular strength is required. The last tool, that illustrated at *E*, is for recessing in the face of a block or for cutting grooves or other work that is held on the chuck or faceplate. These shapes, of course, are for tools held in a toolpost and not for revolving cutters of the Blanchard lathe type.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THOMSON THREAD MILLING MACHINES FOR SHELLS AND RIFLE BARRELS

These machines are special thread milling machines of the "single-purpose" type. One is of the duplex design for threading high-explosive and shrapnel shells, and under average conditions will thread about 50 shells per hour. The other is for threading rifle barrels and receivers. Both are semi-automatic, the disengagement of the spindle-feeding movement and lowering of the cutter from the working position at the completion of the threading operation being controlled by positive and accurate trip mechanisms.

When high-explosive shells are made from bar stock a disk-shaped plug, commonly known as a "gas plug," is screwed into a recess in the base of the shell to prevent the possibility of premature explosion due to any minute seam which might exist in the center of the stock. The thread must extend to the bottom of the recess so that the plug can be screwed in against it. A special machine designed for threading shell bases and also the "nose" or open-end is illustrated in Figs. 1 and 2. This machine is manufactured by A. Morris Thomson, Harrison, N. J., and has been placed on the market by the Walter H. Foster Co., 50 Church St., New York City. As will be seen, it is of the duplex type, there being two independent heads so that one man can readily attend to what is practically two machines. The general arrangement of one of these heads is indicated by the sectional diagram Fig. 3.

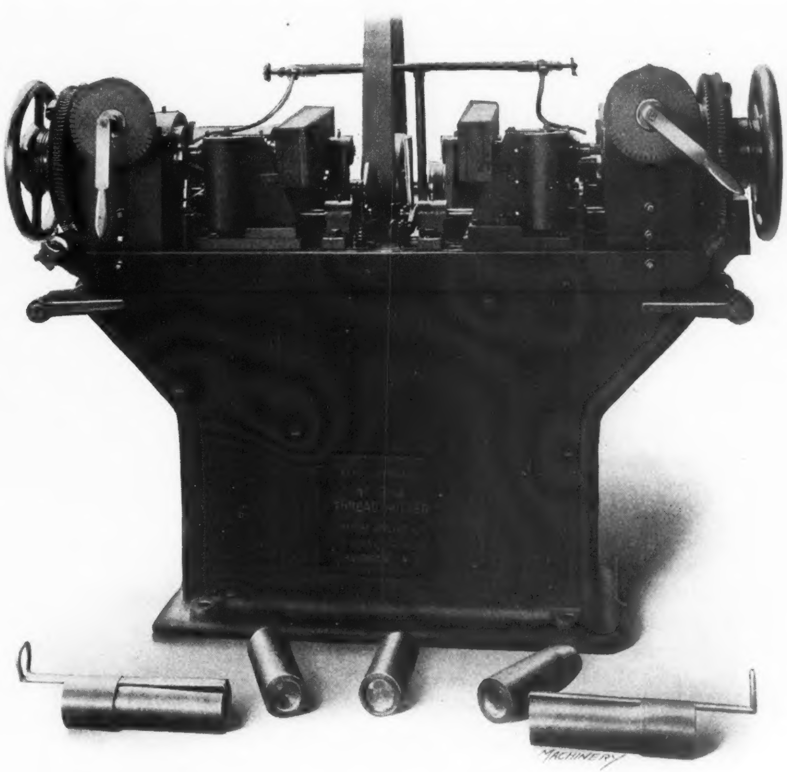


Fig. 1. Thomson Semi-automatic Thread Milling Machine for threading Shells

The shell itself is held inside collet *A* which is opened or closed by operating handwheel *B*. The collet is located inside of hollow spindle *C* which is splined to a driving worm-wheel *D* so that it is rotated by the worm-wheel but is free to move axially. The worm *E* that drives the worm-wheel is connected through bevel gears with a shaft at the rear of the machine, which may be driven by a belt from an overhead shaft or motor belted direct. This rear shaft and the arrangement of the gearing for driving both the work-spindles and the cutter-spindles, is shown in Fig. 2. The cutter-spindles are driven by silent chains and they can be stopped independently by means of clutches on the belt pulley shaft, which are engaged by levers seen in Fig. 1 at the right and left.

When the machine is in operation the spindle *C* moves longitudinally as soon as the segment nut *F* comes into engagement with it. This vertical movement of the nut is effected by means of an eccentric on shaft *G*; the latter extends to a point near the center of the machine and has a lever attached to its end as shown in Fig. 1. At *H* there is another eccentric which moves the cutter-slide and cutter up to the working position at the same time that nut *F* is engaged with the spindle. When the shell is to be threaded, it is inserted through the collet and up against positive stops at the end of the spindle. After being clamped in position in the collet chuck, the spindle *C* is moved forward toward the cutter until the bottom of the recess in the shell comes against a fixed stop attached to the cutter-slide. The end of this stop is practically in line with the end of the cutter, there being just enough difference in the positions to prevent the cutter from marking the bottom surface of the recess to be threaded. This longitudinal movement of the spindle is effected by means of a lever which is located in front of a large graduated dial as shown in Fig. 1. The shaft upon which this lever is mounted carries a small pinion at *J* which meshes with the thread of the spindle, thus moving the latter axially.

When the shell has been placed against the stop previously referred to, it is in position for milling; the cutter, which operates on the upper side of the hole, is next moved up into the working position by rotating shaft *G*, as previously mentioned, and nut *F* engages the spindle simultaneously. The spindle now moves to the left at a rate dependent upon the pitch of the thread engaging nut *F*, which corresponds with that of the thread being milled. Thus it will be seen that the cutter begins at the inner end of the hole, and as the work moves to the left the thread is milled. The graduated dials in front of each head enable the operator to engage the spindle nuts at a time when they will mesh properly with the spindle threads.

This machine is equipped with multi-threaded cutters or those having several rows of annular teeth. These cutters are 1¼ inch in diameter, whereas the recesses in the shells are 2¾ inches in diameter, in the case of the 18-pound British shell for which this machine was designed. The cutters operate at a surface speed of 125 feet per minute and the shells make one revolution a minute. The thread, which is a Whitworth standard of 14 pitch, is completed in 1⅛ revolution of the work-spindle. As soon as the thread is finished an automatic tripping mechanism serves to drop the cutter-spindle and also the nut which engages the work-spindle. Each cutter-spindle is carried by a supplementary slide so that it can be adjusted vertically independently of the vertical movement obtained from eccentric *H*. This vertical adjustment is only needed when setting up the machine. The cutter is, of course, set to conform with the helix angle of the thread and it is fixed in the proper angular position, since this is a "single-purpose" machine. Cutting lubricant is supplied to the cutters by means of a pump which is driven from the rear shaft as shown in Fig. 2. Some of the shell blanks are shown in the foreground of the illustra-

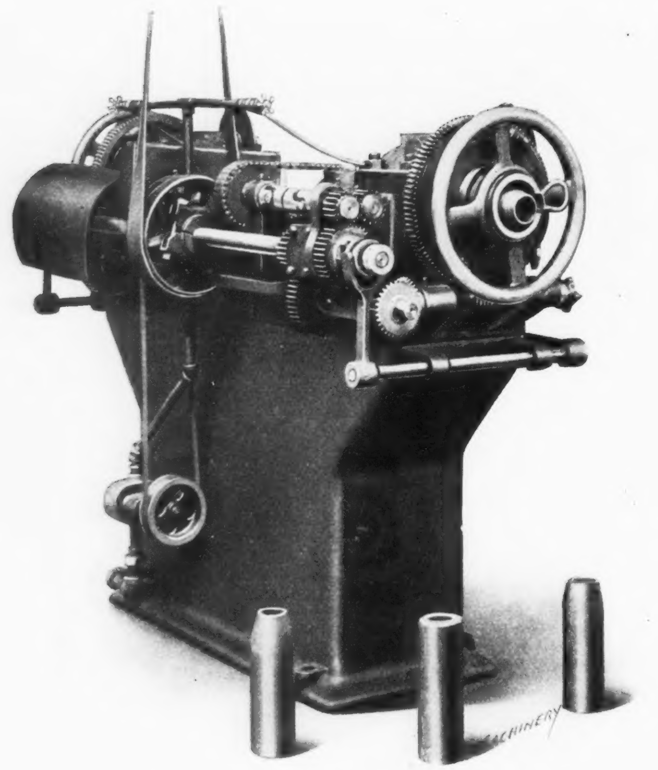


Fig. 2. View of Thread Milling Machine illustrating Driving Mechanism for Cutter- and Work-spindles

tions; two of those illustrated in Fig. 1 have attached to them flat hook-shaped handles which are used for withdrawing the threaded shells from the machine spindles. The actual threading time with this machine is approximately one minute, and the output from both heads varies from 40 to 60 shells per hour, the number naturally depending upon varying conditions.

Another interesting design of thread milling machines is illustrated in Fig. 4. This type is used for milling the threads on the ends of rifle barrels. With a slight rearrangement it is also adapted for the internal threading operation on rifle receivers. As those familiar with rifle construction know, both of these threading operations need to be done very accurately. This machine is simple in its construction and operates on somewhat the same principle as the one previously described. The barrel to be threaded is inserted through and clamped in a hollow spindle of the machine, in which it is located either by a positive stop or by means of a special gage, the exact method depending upon the type of rifle barrel to be threaded. The work-spindle is rotated by means of worm-gearing, the shaft on which the worm-wheel is mounted being driven directly by a belt. The axial feed movement of the work-spindle for milling the thread is obtained by engaging a nut with a thread of a corresponding pitch on the exterior of the spindle, the same as in the case of the shell thread-milling machine. The cutter-spindle is also driven by a silent chain from a shaft at the rear carrying a belt pulley.

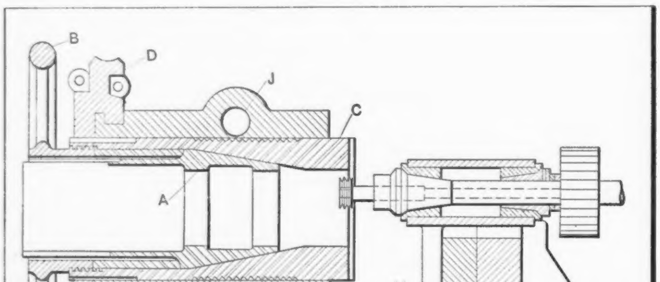


Fig. 3. Diagram illustrating General Arrangement of Cutter- and Work-spindles of Thread Milling Machine

One of the important features of this machine is the automatic tripping mechanism which is so arranged that it can be adjusted to stop the threading operation at a given point within very close limits of accuracy. In connection with this automatic trip, there is an arm mounted on the spindle just in front of the left-hand spindle bearing. This arm engages a second arm located on the shaft seen extending along the center of the bed. When this engagement occurs, the nut meshing with the threaded part of the work-spindle and also the cutter-spindle, drops down, thus stopping the threading operation instantly. The thread has a pitch of 1/16 inch and the arm of the spindle is so adjusted that it just misses the tripping arm of the shaft when beginning the last revolution; consequently, when this revolution is completed it engages the tripping arm, thus rotating the shaft and lowering the nut and cutter-spindle, as mentioned. As soon as the nut is disengaged from the spindle the latter is thrown to the left by the bellcrank and weight shown to the left of the machine, thus bringing the spindle into position for threading another barrel. When this machine is used for threading receivers, a special fixture is attached to the end of the spindle for accurately locating the receiver by means of certain surfaces which are previously machined for that purpose.

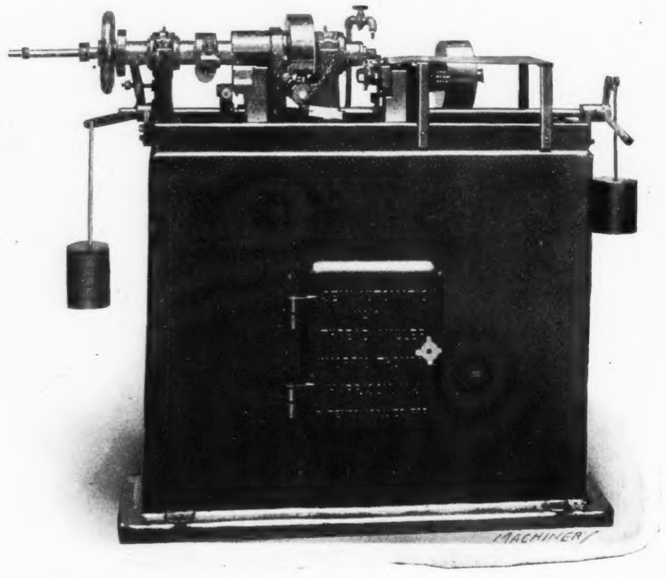


Fig. 4. Semi-automatic Machine for milling Threads on Ends of Rifle Barrels

NATIONAL-ACME STUD AND BOLT THREADING MACHINES

These machines have been developed for performing such operations as threading studs and bolts, and other second operation work on various screw machine products. In each case the illustrations show the entire machine and also a close view of the tools and means provided for feeding the work to the machine. It will be seen that the machines are of the single- and multiple-spindle types; and they are semi-automatic and automatic in operation. The machine shown in Figs. 7 and 8 is a combination tapping and threading machine. In addition, a special grinding machine is illustrated which has been developed by the National-Acme Mfg. Co. for use in sharpening the chasers of the threading dies.

For threading studs and bolts, and for second operation work on different screw machine parts, the National-Acme Mfg. Co., Cleveland, Ohio, has designed several interesting types of machines for bolt and stud threading. These are of the single- and multiple-spindle types, and are semi-automatic and automatic in their operation. Figs. 1 and 2 show one of these machines, having a capacity of from ¼- to ½-inch studs, inclusive, which is known as Size No. 1, Style TM stud threading machine. This is a high-speed automatic machine and is designed for the rapid threading of studs. The construction is comparatively simple, the machine being

driven by a single belt. The speeds of production are controlled by a system of change-gears, and the operating mechanism is controlled by cams mounted on drums, these operating the chuck opening, closing and extracting mechanisms, and also the die-heads for threading. Safety frictions are provided to prevent breakage of vital parts, and the control of the machine is through a single hand lever located at the front of the machine. A pump is provided for forcing cutting lubricants to the tools at work.

In operation, the pieces are dropped into a horizontal magazine, from which they are fed through the receiving tube by means of a push-rod. One of the special features of the machine is the method of feeding and extracting the work. It operates in the following manner: When the die is opened, the jaws holding the threaded piece recede, allowing the piece to drop out, and instantly a new piece is fed up to the stop. The stop is supported in the die spindle and is held stationary; it is adjusted from the rear of the spindle by a lock-nut. Inasmuch as the extracting and feeding operations are practically simultaneous, much of the idle time is saved that is generally required for forcing the piece in and out of the chuck, and oscillating the stop.

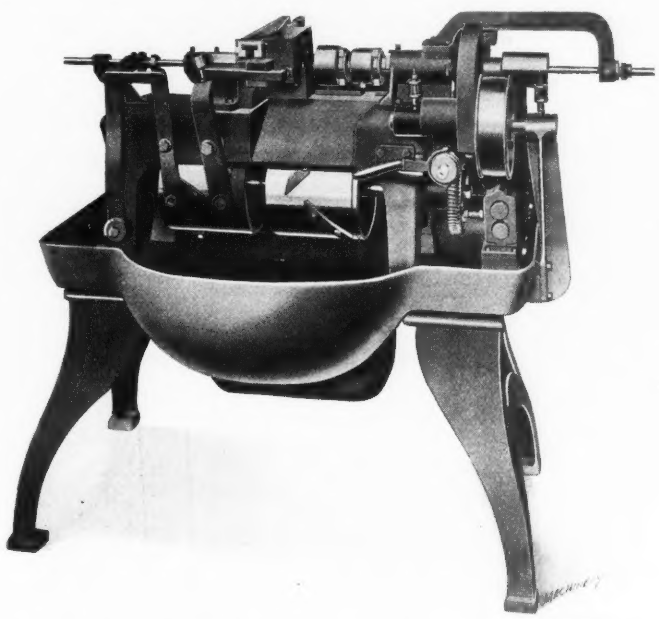


Fig. 1. National-Acme Size No. 1, Style TM Stud Threading Machine

The threading of the work is accomplished with a standard National-Acme self-opening die-head, the work being held stationary while the threading tool revolves. The tool is never forced on, but follows the lead of the thread until the die comes in contact with the stop that is set for the threading length, whereupon it is automatically tripped open and backed off without reversing. Upon the backward movement, the die chasers are closed. Table I gives the change-gears supplied with this machine, together with the possible production in ten hours secured by the different gears; and this production, of course, is worked out on the basis that the machine is operated continuously for the time specified. Table II gives a list of the back-gears that control the spindle speed for various diameters of work, the spindle speed being based on a cutting speed of 35 surface feet per minute. This machine works very efficiently and when fitted up with a National-Acme self-opening die makes possible a large production of accurate work.

National-Acme Automatic No. 2 Stud Threader

The automatic stud threader shown in Figs. 3 and 4 has a capacity for handling studs varying from ½ to 1 inch diameter. inclusive. This machine can be used for threading both ends of the stud, either from the blank form or for second operation work; and also other classes of work of the same general shape and size. The construction of this machine resembles very much the National-Acme automatic multiple-spindle screw machine. The power is supplied to

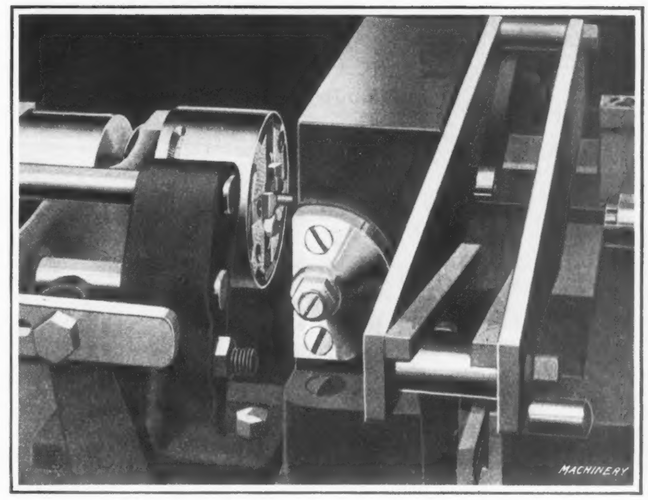


Fig. 2. Close View of Threading Die and Magazine Feed on Machine shown in Fig. 1

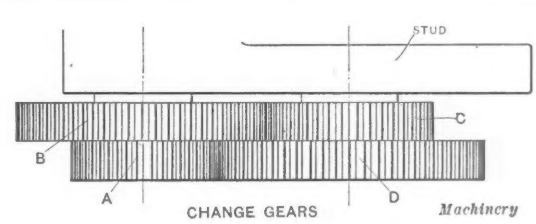
the machine through a single belt and a change-gear mechanism to cam drums, one controlling the feeding operation of the machine and the other the advance of the slide carrying the opening die. The magazine, in this case, is of the vertical type.

In operation, the stud blanks are placed in the magazine by the operator and pass from the bottom of the magazine, one at a time, into a receiving tube located at the back of the chuck, by means of a cam-controlled movement of the feed-in slide. From this tube, each blank is chucked in turn by a push-rod. In feeding in a new blank, the finished stud is automatically extracted as the die recedes; and since the spindle and chuck holding the work do not revolve, there is no tendency to clog or wind the blank in the spindle tube. Adjustment for various sizes of studs consist in expanding the guide walls of the magazine for the length of piece and substituting a chuck of the required capacity. The spindle tube is changed for extreme sizes only. The National-Acme self-opening die of the revolving type is used on this machine as well as the standard stock shaper.

National-Acme Two-spindle Bolt Threader

Figs. 5 and 6 show a special two-spindle machine designed by the National-Acme Mfg. Co., which is known as the No. 2 bolt threader. This machine has a capacity for threading bolts varying from 3/16 to 5/8 inch in diameter of V or

TABLE I. CHANGE-GEAR TABLE AND PRODUCTIVE CAPACITIES OF NATIONAL-ACME NO. 1 STUD THREADER



Gears on Worm Shaft		Gears on Stud		Number of Pieces Threaded in Ten Hours
A	D	B	C	
59	29	29	59	39,500
53	29	35	59	29,400
50	29	38	59	25,600
47	29	41	59	22,200
44	29	44	59	19,500
41	44	32	29	18,500
47	35	32	44	17,600
53	41	35	47	16,500
41	32	35	44	15,400
53	44	44	53	13,900
35	29	53	59	12,800
35	32	50	53	11,100
29	29	44	44	9,550
29	35	47	41	6,900

Machinery

TABLE II. LIST OF BACK-GEARS AND DIE SPINDLE SPEEDS FOR VARIOUS DIAMETERS OF STUDS

Diameter of Work, Inches	Gear on Pulley Shaft	Speed in R. P. M.
1/4	71	535
5/16	59	440
3/8	47	350
7/16	41	305
1/2	35	265

Machinery

U. S. S., or S. A. E. thread up to 1 inch diameter. In addition to being capable of threading screw blanks, whether forged or turned to shape, this machine can also be used for threading bars of different lengths. The threading mechanism consists of two spindles for carrying the thread cutting dies, the spindles being driven through change-gears by a single belt. Located in line with the threading spindles are two slides upon which blocks are fastened for carrying the work to and from the dies. Lubricant is forced into the threading tools by means of a pump and the machine can be operated either in a right- or left-hand direction.

Fig. 3. National-Acme Size No. 2, Style TM Stud Threading Machine

In operation, the blanks are pushed into the holder by hand and held rigid for threading without locking, thus reducing the operating time. The slide is then fed forward by a hand lever shown, until the die begins to cut. The lever is then released and the work advances by the action of the lead of the thread itself. When National-Acme self-opening dies are used, it is not necessary to reverse the threading spindle. After the proper length of thread has been cut, the adjustable stop engages a fork fitted into the spool of the die and trips it automatically. The backward movement of the slide for extracting and reloading also closes the die. Holders

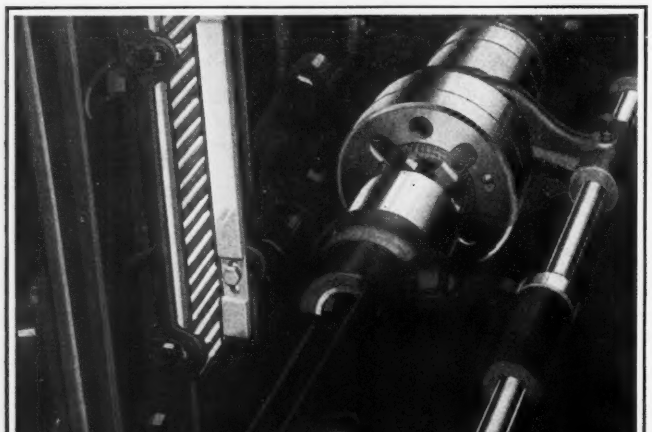


Fig. 4. Close View of Die and Magazine Feed on Machine shown in Fig. 3

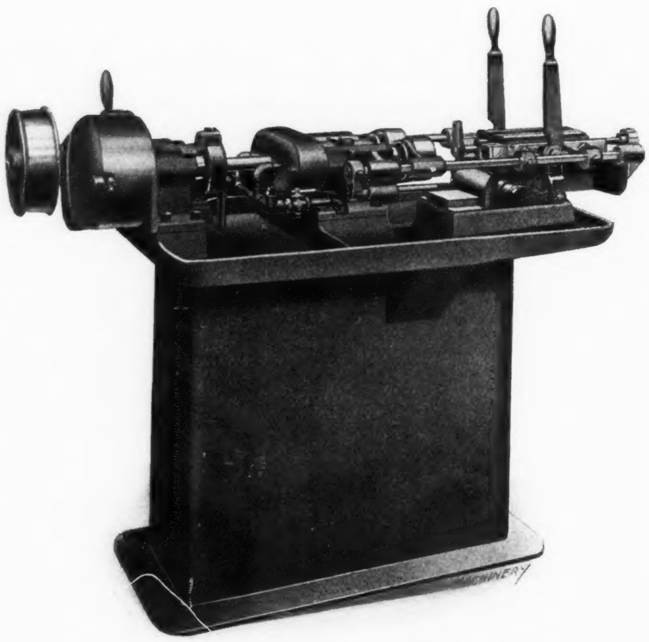


Fig. 5. National-Acme Two-spindle No. 2 Bolt Threader

with interchangeable grips for standard sizes of hexagon and square head screw blanks are furnished from stock. For special work, of course, it is necessary to make up grips that will hold the work satisfactorily. For bar threading, ways are cut in the blocks used and a stop operated from the rear holds the bar in place. Table IV gives the productive capacity of the bolt threaders shown in Figs. 5 and 7. It will be noticed that this table covers threads varying in diameter

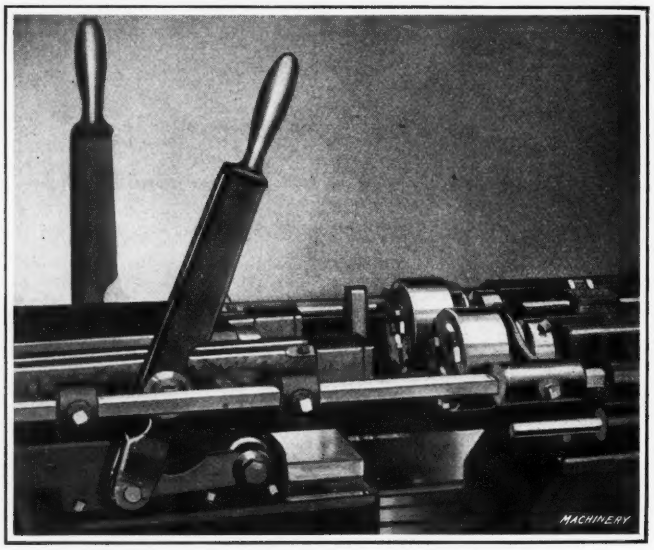


Fig. 6. Threading Dies and Feed Mechanism on Machine shown in Fig. 5

from 1/4 to 3/4 inch, and in pitch from 20 to 10 threads per inch. For finer threads than those given in the table, multiply the production by 4/3. The length of thread given here varies from 1/4 to 4 inches. The production figures, of course, are based on continuous operation of the machine and do not take into account stoppages for sharpening, setting, etc.

TABLE III. CHANGE-GEARS USED FOR VARIOUS DIAMETERS OF BOLTS AND DIE SPEEDS

Diameter of Bolt	Gear	R. P. M. of Die
1/4 x 20	24	450
5/16 x 18	29	370
3/8 x 16	35	310
7/16 x 14	41	265
1/2 x 13	47	230
9/16 x 12	53	205
5/8 x 11	59	185
3/4 x 10	71	150

Machinery

Table III gives the change-gears used for different sizes of threads, and the resulting revolution of the die secured by their use. These die speeds are based on a cutting speed of 30 surface feet per minute. For fine pitch threads, take the next highest gear in the table. For instance, for 5/16 by 25, gear 24 instead of 29 would be used.

TABLE IV. AVERAGE ESTIMATED PRODUCTION OBTAINED ON NO. 2 AND NO. 2A NATIONAL-ACME BOLT THREADERS

Diameter and Pitch of Thread	Length of Threaded Portion in Inches										
	¼	⅜	½	⅝	¾	1	1¼	1½	2	3	4
	Average Production in Ten Hours										
$\frac{1}{4}$ x 20	15,000	14,500	14,000	13,500	12,500	11,500	10,500	9750	8500	6750	....
$\frac{5}{16}$ x 18	......	14,000	13,500	13,000	12,000	11,000	10,000	9250	8000	6250	....
$\frac{3}{8}$ x 16	......	13,000	12,500	11,750	11,000	10,000	9,000	8250	7200	5500	....
$\frac{7}{16}$ x 14	......	......	12,000	11,250	10,750	9,500	8,750	8000	6750	5250	4250
$\frac{1}{2}$ x 13	......	......	11,500	11,000	10,250	9,500	8,500	7750	6250	4750	3750
$\frac{9}{16}$ x 12	......	......	......	11,000	10,000	9,250	8,500	7500	6000	4500	3500
$\frac{5}{8}$ x 11	......	......	......	10,800	9,750	9,000	8,000	7000	5500	4250	3250
$\frac{3}{4}$ x 10	......	......	......	......	9,500	8,500	7,500	6500	5000	4000	3000

Machinery

National-Acme Two-spindle Bolt Threader and Tapper

Figs. 7 and 8 show what is called the No. 2A tapper and threader This machine has a capacity for threading V or U. S. S. threads from 3/16 to 5/8 inch in diameter, inclusive, and S. A. E. threads up to 1 inch diameter. For tapping, it would handle V or U. S. S. threads, 15/32 to 5/8 inch diameter, inclusive, and S. A. E. threads up to 1¼ inch diameter. It is adapted, of course, for threading bolts and screw blanks, spring clips and bars of any length; also for tapping, in which case collapsible taps would be used. The general design of this machine is similar to the No. 2 bolt threader just described, except that the work-holders are of slightly different design. In place of blocks mounted on tool-slides and carrying standard or special work-holders, this machine is provided with two double-grip vises in which special jaws are inserted for different shaped work.

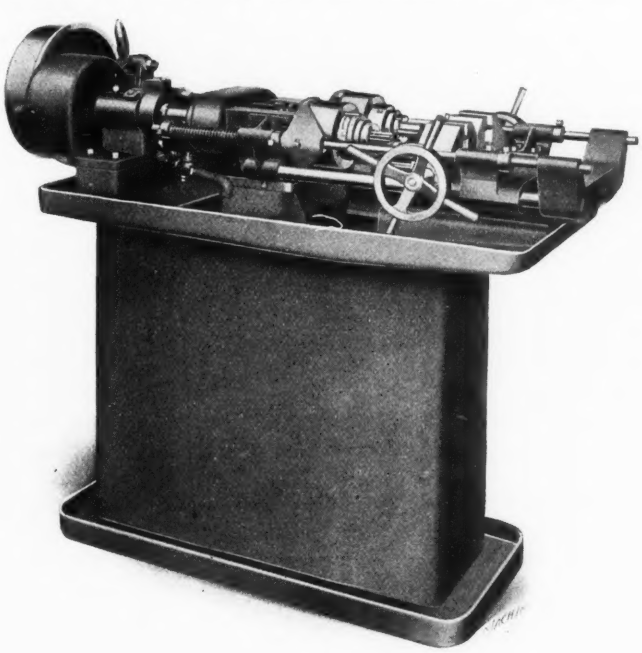


Fig. 7. National-Acme No. 2 A Bolt Threader and Tapping Machine

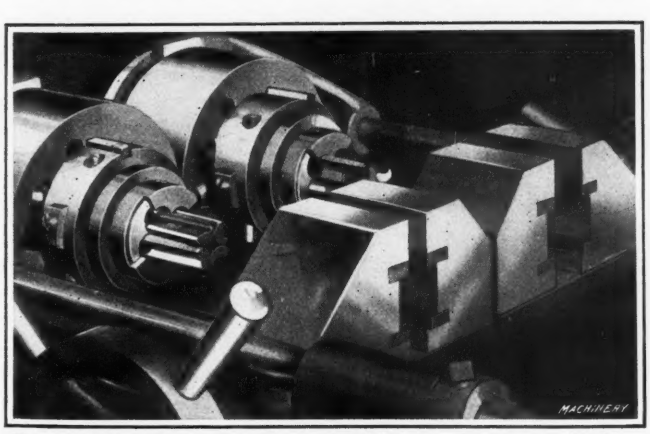


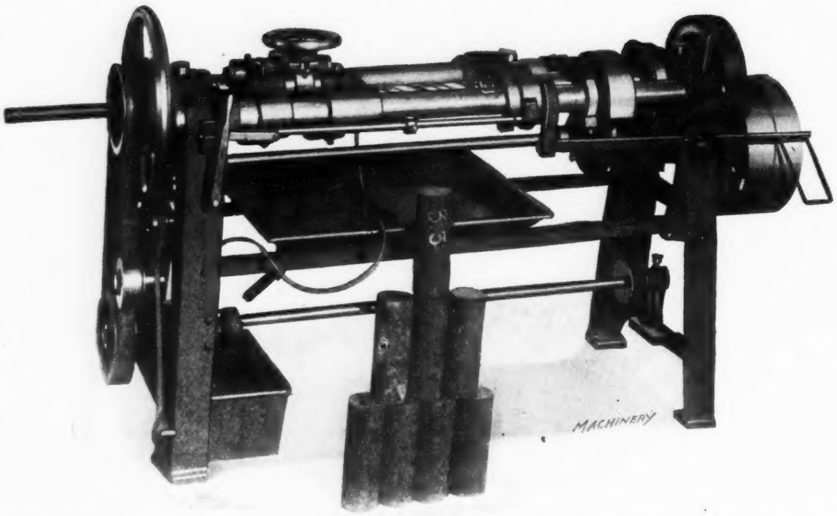
Fig. 8. Close View of Tools and Work-holding Fixtures on Machine shown in Fig. 7

In operation, the work is placed in the holding jaws and locked in alignment with the collapsible tap by means of the turnstile wheel which closes the vise jaws. The slide is then advanced by hand to engage the die or tap, after which the lead of the thread is depended upon for further movement, which insures an accurate pitch of thread on the work. The threading or tapping operation continues until a gage lever comes into contact with the adjustable stop, when the die or tap is automatically tripped and freed from the work. The backward movement of the slide sets the die or tap ready for the next feed. Feeding and extracting are alternate operations, so that the production rate is dependent upon the operator's skill as well as the class of work. The dies used on this machine are the National-Acme self-opening die-heads, and the taps are those made by the Manufacturers Equipment Co.

Fig. 9. Special Grinding Machine for sharpening Chasers of Threading Dies

A. R. WILLIAMS DRILL FOR HIGH-EXPLOSIVE SHELL BILLETS

The machine which is illustrated and described herewith is known as the Boyd heavy-duty horizontal drilling machine;



A. R. Williams Heavy-duty Drilling Machine for drilling 18-pound High-explosive Shell Billets

it has been developed for use in drilling the billets for 18-pound high-explosive shells and is sold by the A. R. Williams Machinery Co., Ltd., 64-66 Front St., W., Toronto, Canada. Reference to the illustration will make it evident that the machine is of simple design and rigidly constructed to stand up under the severe service for which it is intended. The billet to be drilled is held in a vise which is equipped with a quick-return mechanism to reduce non-productive time to a minimum. An automatic trip is provided on the side of the machine which disengages the feed when the billet has been drilled to the required depth. The trip can be set to disengage the feed at various points, and the rates of feed available are 0.012 and 0.016 inch per revolution. The power is transmitted to the spindle through a single set of reduction gears which provides a drive of high efficiency. Owing to the fact that the drill works in a horizontal position, the chips clear themselves quite readily and there is no tendency for the drill to bind in the hole. Approximately 5 horsepower is required to drive the machine, and its weight is 1200 pounds.

BESLY WIDE-FACE RING WHEEL GRINDER

This machine is of similar design to the Besly single-spindle lever-feed disk grinder, but in the present case one end of the spindle is equipped with a pressed steel chuck for holding a wide-faced vitrified ring wheel. This wheel has from 8 to 10 inches of grinding face so that work may be allowed to "float" in the same manner as on the disk wheel. This arrangement of the ring wheel is the means of greatly increasing production on those classes of work where it is necessary to remove scale and a considerable amount of excess stock. On former designs of Besly grinders equipped with a ring wheel chuck for rough grinding, the face of the wheel was comparatively narrow, making it necessary to clamp the work in place before starting the grinding operation.

Charles H. Besly & Co., 120B N. Clinton St., Chicago, Ill., have just placed on the market an improved flat surface grinder called the Besly wide-face ring wheel grinder. This machine is similar to the single-spindle, lever-feed Besly disk grinder except that for roughing off scale and excess stock one end of the spindle is equipped with a pressed steel chuck holding a wide-face vitrified ring wheel. This grinding wheel has 8 to 10 inches of grinding face, so that work may be allowed to "float" on its broad face while grinding in the same manner as on the usual steel disk wheels covered with cloth abrasive disks. These vitrified grinding wheels are more efficient and economical than cloth-back abrasive disks for heavy rough-grinding on scale; in fact, large rough work may be accomplished on the wide-face ring wheel grinder which cannot be done at all on the ordinary disk grinder.

Fig. 1. Besly Wide-face Ring Wheel Grinder

Besly grinders have heretofore been equipped with ring wheel chucks for rough-grinding, but with comparatively narrow-faced ring wheels which made it necessary to rigidly clamp any work that was to be ground. The advantage of the wide-face ring wheel, as compared with the ordinary narrow-face ring wheel, is that much work may be "floated" against the wide-face wheel as in disk grinding, and ground without clamping. This saves time in chucking. There is a further saving in the time of grinding because with the wide-face ring wheel more cutting points are in action, as it grinds all over the face of the work at once. The opposite end of the spindle is equipped with the usual steel disk wheel set up with cloth back abrasive disks for finish-grinding.

Construction of the Pressed Steel Chuck

The construction of the pressed steel chuck is clearly shown in Fig. 2. The chuck body is made of pressed steel, double riveted to a cast-iron center; and the construction of this center is such that the spindle bearing projects into the chuck, thereby minimizing overhang. The chuck body is drilled and tapped from the back to receive headless threaded plugs for balancing. The grinding wheel is held in the chuck by pressure over its periphery, this pressure being applied by means of a wrought steel tapered clamping ring passing around the grinding wheel. This ring is drawn into the tapered chuck body by means of clamp screws operated from the back of the chuck body. A suitable steel plate is provided to fit the center hole of the grinding wheel and guard the heads of the screws which hold the chuck on the grinder spindle; so there are no external projections. This makes the chuck especially safe. As the grinding wheel wears away, it may be set out in the chuck by means of the laminated wooden plate supplied with the chuck, which is shown in Fig. 2. The Besly wide-face ring wheel grinder is built in two sizes: one of these is a No. 17 machine carrying a vitrified grinding wheel 24 inches in diameter by 8 inches width of grinding face; the other is a No. 16 machine carrying a vitrified grinding wheel 30 inches in diameter by 10 inches width of grinding face. All ring wheels are 3 inches thick when new, and may be worn down to 1 inch in thickness.

Work Done by Grinder

This new grinder competes with planers, millers, and shapers; and examples of economical surfacing are shown in Figs. 3 and 4. Fig. 3 shows the grinding of pillow-blocks and caps; the 6 by 13 inch surface of these cast-iron pillow-blocks was formerly machined on a variable-speed, motor-

driven shaper, using high-speed steel tools to the limit of their capacity. In order to make this piece suitable for grinding instead of shaping, the pattern was changed. Very little stock was left for finish, and the surface was recessed in molding to facilitate grinding. By a little care on the part of the molder, these castings came to the grinder with a maximum of 1/16 inch of stock left for finish. The No. 17 Besly wide-face ring wheel grinder roughed and finished these surfaces to size and flat in less than two minutes. The former time on the shaper was about twenty minutes.

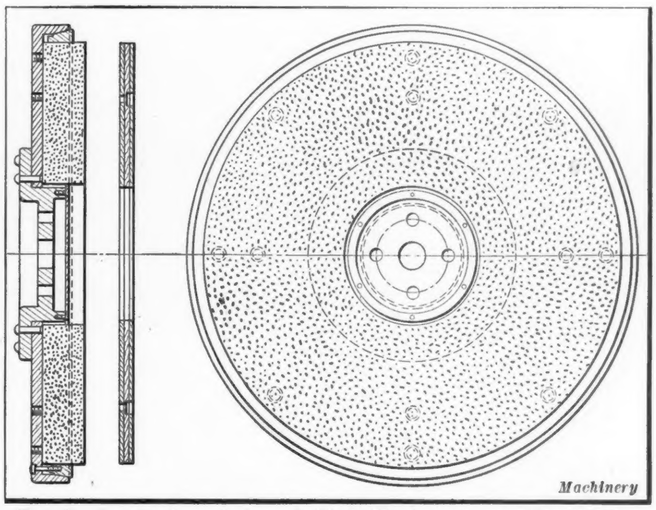


Fig. 2. Construction of Pressed Steel Chuck used on Besly Grinder

Allowing for careless molding, necessitating the removal of 1/8 inch of stock, the No. 17 Besly grinder accomplishes the work in three minutes as against twenty minutes for the shaper. The time given covers all work, floor to floor, including the making of a surface plate test to determine the accuracy of the work. It will be noted that these heavy pillow blocks and caps are ground without rigid chucking, *i. e.*, the work "floats" against the grinding wheel both in the roughing and finishing operations.

Fig. 4 shows the grinding of automobile gear shifter covers; these castings are of malleable iron and rather frail. As they are ground without rigid chucking, there is no chance to distort the casting as in cases where they must be rigidly clamped for milling. The grinder work-holder is very simple. The work rests loosely on three studs projecting from the face of the angle-plate, and the work is located and supported on this three-point bearing by means of four studs projecting from the angle-plate. The time on this job is 200 grinding operations per hour per operator, or 100 castings roughed and finished per hour per operator. As each machine accommodates two operators, the production per machine is double that mentioned, or 200 castings roughed and finished per hour.

Geared Lever-feed Table

The geared lever-feed work-table used on this Besly grinder gives the operator a leverage of 20 to 1, so that with a very slight pressure of the operator's hand, the work is forced against the grinding wheel with sufficient pressure to secure maximum grinding efficiency. The work-holders used on these machines are simple and inexpensive. The grinding wheels are also cheap as compared with the high-speed steel cutters required by other types of machine tools, and the tool-making and upkeep expense is practically nothing. The machines are operated by comparatively cheap and easily replaced labor. Fast production and extreme accuracy may be maintained. To secure the best results, it is necessary to use care in designing, patternmaking and molding, so that the work may come to the grinder with the minimum amount of stock left for finish, and large surfaces should be relieved to facilitate grinding.

Fig. 3. Grinding Pillow Blocks and Caps on Besly Wide-face Ring Wheel Grinder

BAUSH RIFLING MACHINE

One of the latest products of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., is the rifling machine which is illustrated and described herewith. The driving pulley is located at the far side of the machine, and the power is transmitted through a positive clutch which provides for disengaging the drive. The remainder of the transmission consists of a pair of spur gears and a pair of elliptical gears, the arrangement being such that a practically uniform motion is provided for the rifling bar. The "twist" is obtained from an adjustable pattern bar, the shoe being fastened to the lower end of the rack. This rack drives an intermediate spindle which, in turn, drives the rifling spindle. Each of these spindles has a loose gear at the rear end, and there is a spiral spring, the ends of which are connected to the gears on the spindles, to provide for taking up back-lash in the gears and the rack and to hold the shoe down in firm contact with the pattern bar.

A brush is located at the end of the barrel to wipe the chips off the cutter just before it comes to the end of the stroke. The feed mechanism and the index mechanism are operated by a cam, through bellcranks connecting with rods at the back of the machine. The pump is driven by a sprocket chain on the crankshaft; and a rod at the front of the pattern bar provides for disengaging the clutch when it is required to stop the machine. An idea of the rate at which this machine operates may be gathered from the fact that a rifle barrel 32 inches in length, with four grooves 0.005 inch in depth and making one turn in a length of 7 1/2 inches, has been completely rifled in about 18 minutes. The work was done with a "hook cutter," experience having shown that a

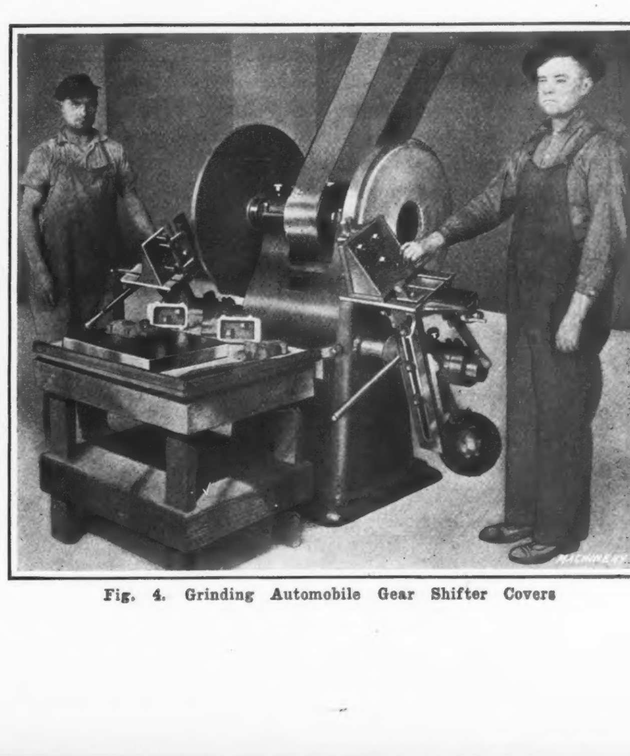
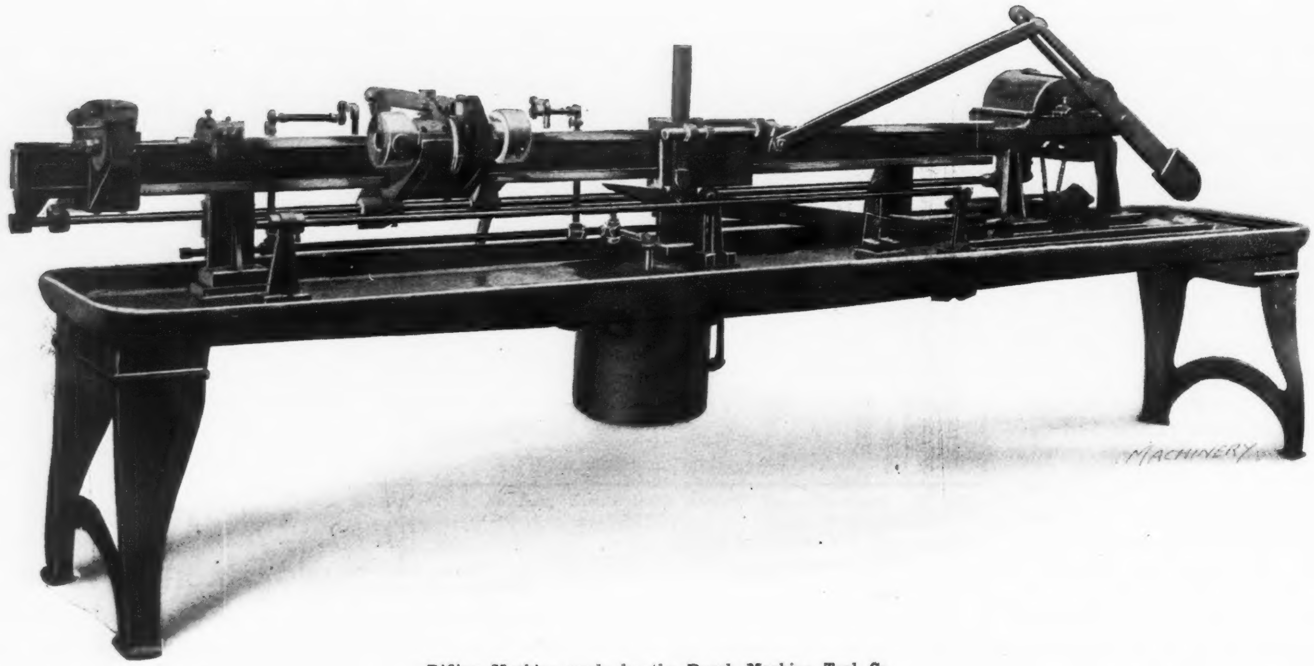


Fig. 4. Grinding Automobile Gear Shifter Covers



Rifling Machine made by the Baush Machine Tool Co.

"scrape" cutter did not work as rapidly or give as good results on the particular class of steel used for the rifle barrel referred to. A feature of this machine is that if the cutter jams, the belt is thrown off without damaging the tool. It was found that a mixture of kerosene and lard oil was the best cutting lubricant, this being far superior to clear lard oil.

DEANE HIGH-PRESSURE HYDRAULIC PUMP

A 250-gallon horizontal duplex hydraulic pump capable of developing a pressure of 3000 pounds per square inch, is shown in the accompanying illustration. This unit was recently built by the Deane Steam Pump Plant of the International Steam Pump Co., Holyoke, Mass., for use in connection with hydraulic drawing presses. All of the water-end parts which are subjected to internal pressure are made from solid steel billets, and all valves are separately accessible through individual hand-holes. The high-speed pinion-shaft bearings are of the multiple ring-oiler type, and the crankshaft bearings are of the quarter-box type with wedges provided on both sides so that the gear centers may be maintained. The crank disks are open-hearth steel castings and the pins are cast integral with the disks.

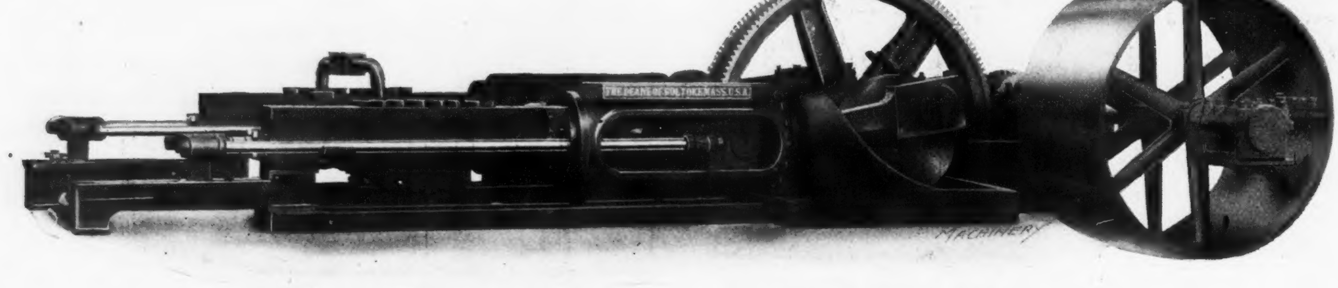
Both the inside and outside cross-heads are also steel castings, the inside cross-head being fitted with adjustable shoes running in a bored guide. To insure accessibility of the cross-head shoe adjustment, the shoes are adjustable from the front or connecting-rod end of the cross-head, instead of having this adjustment made from the rear or plunger end. It will be noticed that the girders underneath the pinion shaft bearings are cast integral with the pedestal bearings or frame, this construction being employed to obtain the maximum rigidity and permanent alignment of all parts.

KANE & ROACH STRAIGHTENING, SIZING AND REELING MACHINE

Kane & Roach, Syracuse, N. Y., have added to their line a machine for preparing the stock ready for use in nut machines. It provides for rolling the material down to correct size, straightening it both flatways and edgeways and recoiling it ready for use. Practically any shape and size of material can be handled by the machine, and the rolls are made of carbon tool steel and so designed that passes can be provided for three or four different sizes or shapes of stock on each set of rolls. The rolls have bearings at both ends which are massively constructed to prevent the probability of deflection, with the result that the stock is rolled down to within a limit of 0.001 inch of the required dimension. The stock is fed through the machine at from 50 to 60 feet per minute. The machine illustrated takes stock from 1/4 to 7/8 inch in width by 3/8 inch in thickness.

The stock comes to the machine in rough coils in the condition that the metal leaves the rolling mills, and runs between the guiding rolls into the sizing rolls; there are two sets of sizing rolls, the first of which reduces the material almost to the required size while the second set reduces it to size and produces the required finish. Between the two sets of sizing rolls there is a set of rolls which straighten the material edgeways, and after it has passed through the second set of sizing rolls it enters still another set of rolls which straighten it flatways before being wound on the reel. The reels used on the machine are 30 inches in diameter and have a width of 5½ inches between the forks; 1000 pounds of stock can be wound on each reel. Change-gears are provided on the machine for varying the speed of rotation and travel of the reel.

In winding up the material the reel travels up or down while it is revolving, so that the line of travel of the stock



High-pressure Hydraulic Pump built in the Deane Steam Pump Plant of the International Steam Pump Co.

remains constant while it is being wound up, *i. e.*, the reel moves to the stock instead of having the stock move to the reel. The change-gear box provides for regulating the rate of travel of the reel according to the width of material which is being handled. It is stated that the material is wound on the reel with the same degree of perfection with which cotton or silk is wound up on a spool. The reel can be quickly lifted off the machine and placed on the spindle in front of the nut machine from which it is fed into the machine and made into nuts. The use of one of the Kane & Roach machines enables nut manufacturers to buy the stock in the form in which it comes from the rolling mills, *i. e.*, with considerable variation in size and with the stock quite crooked; they can then pass it through the straightening and sizing machine to put it in condition for feeding to the nut machine.

Experience has also shown that it is a great advantage to have a 3-degree bevel on the edges of the material, because in punching the nuts there is a tendency for them to swell at the bottom. By beveling the stock before it is fed to the nut machine, this difficulty is overcome, as suitable compensation has been made for this tendency to swell. In addition to sizing the stock and straightening it both flatways and edgeways, the Kane & Roach machine also provides for rolling the required 3-degree bevel on each edge. The weight of the machine is about 5 tons, and it is arranged for individual motor drive, the motor being geared direct to the machine.

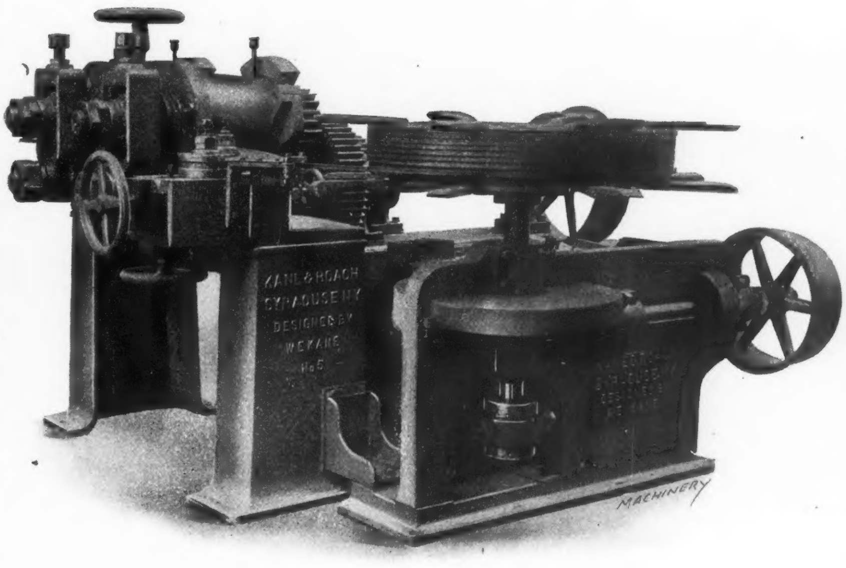


Fig. 1. Kane & Roach Straightening, Sizing and Reeling Machine

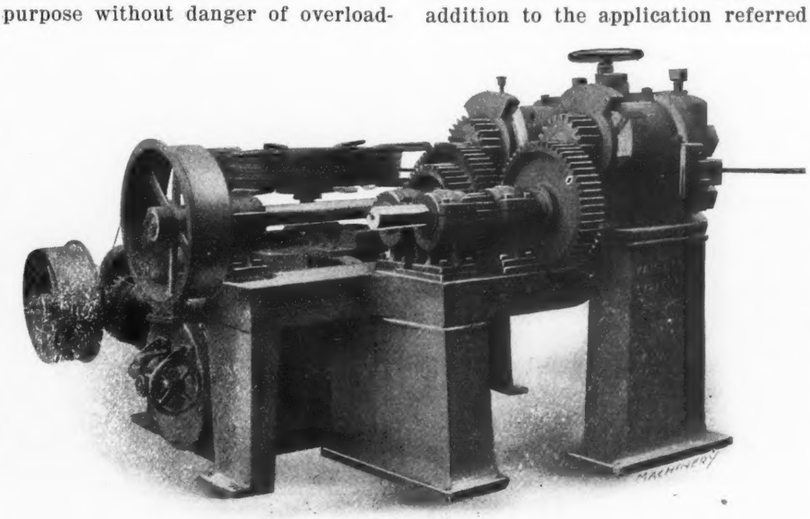


Fig. 2. Opposite Side of Kane & Roach Machine shown in Fig. 1

AUTOMATIC ELECTRICAL TOOLS

The Automatic Electrical Tool Co., Western Ave. and Bank St., Cincinnati, Ohio, has recently been incorporated to engage in the manufacture of portable electrical tools. The outfit illustrated in Fig. 1 is one of the products of this firm, and is known as a combination lag screw drilling and driving machine; it was originally developed for the class of work indicated by its name, but other uses have since been found for the tool, the scope of which will be gathered by referring to the group of auxiliary tools shown in Fig. 1. A feature of the design is that the tool is equipped with a mechanically operated quick make-and-break switch which enables it to be used for practically any purpose without danger of overloading the motor and burning out the windings. This switch also acts as an automatic stop for the feed when a screw, tap, reamer or other tool has been driven to the required depth.

The tool is driven by a 1 horsepower series reversible motor which can be used on 110, 220 or 500 volt direct current; or a universal motor may be provided which is adaptable for use on either alternating or direct current. The reversible motor drive makes it possible to perform tapping or threading operations, or to use the tool for backing out screws; and the automatic switch disengages the feed at the required point. The tool has also found favor in the shipping rooms of machine tool building factories where it is employed for crating machinery. Still other applications are for use in facing the ends of bearing boxes after they have been assembled in a machine and for driving staybolts.

It will be seen that the spindle is located off center, which enables the tool to reach into corners; this design also eliminates the tendency for the tool to twist, and as a result it is easily held. The drill chuck is secured to the side handle and is advanced for drilling the required depth of hole; when the tool is used for driving lag screws the drill is drawn back to expose the square socket which receives the head of the screw or bolt. Hess-Bright or S. K. F. ball bearings are used throughout, and all bearings are enclosed in grease-tight cups. The principal dimensions of the machine are as follows: Available speeds, 60 R. P. M. and 400 R. P. M. under load; capacity for driving drills up to 3/4 inch in diameter when running on the high speed, taps up to 1 1/4 inch in diameter and hand reamers up to 2 1/2 inches diameter; capacity for threading pipe or bolts up to 3/4 inch in diameter; and power of motor, 1 H.P. The weight of the machine is 30 pounds.

Drill and Screwdriver

The combination drill and screwdriver illustrated in Fig. 2 is provided with two spindles which run in opposite directions, the available speeds being 125, 250, 375, and 500 R. P. M. This tool is primarily intended for driving wood screws, a drill being used in one spindle to make the hole and a screwdriver in the other spindle which is used to drive the screw home. The spindles run in opposite directions and the tool is provided with an automatic switch that breaks the connection when the screw is driven home—or in the event of the drill striking a hard spot in the work—and prevents the possibility of burning out the motor. The motor used on this tool is not reversible. Both spindles on the tool remain stationary until they are pressed down upon the work which causes the engagement of a positive clutch. In addition to the application referred to, this tool can also be provided with suitable sized sockets for use in tightening nuts on wood. It can also be used as a hand tool, and this allows the power of the motor to be augmented by manual power. Ball bearings are used throughout. The maximum capacity of the tool is for driving 4-inch No. 16 screws in pine without first drilling a hole for the screw. This is about what a manually operated brace can do. The weight is 5 pounds.

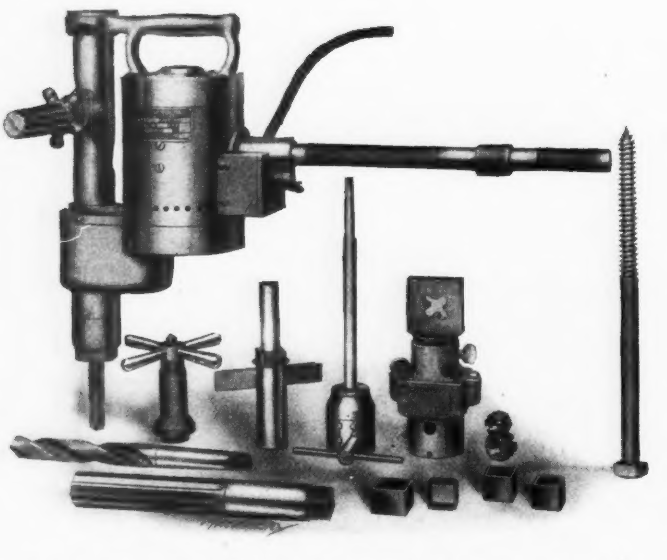


Fig. 1. Combination Lag Screw Drilling and Driving Machine made by the Automatic Electrical Tool Co.

Automatic ¼-inch Drill

The Automatic Electrical Tool Co. is also manufacturing a tool known as a ¼-inch drill which is essentially the same tool as the combination drill and screwdriver illustrated in Fig. 2, except that it has only one spindle and chuck. The feature of the tool is its extremely light weight, which enables it to be held with one hand while the work is steadied with the other hand, thus saving the time which would otherwise be required for clamping the work. The available speeds are 1000 R. P. M. and 1500 R. P. M. which are suitable for driving ¼- and 3/16-inch drills, respectively. The drive from the armature spindle to the drill is through a train of spur and spiral gears, and the spindle is supported in long bronze bearings to give permanent alignment, while the end thrust

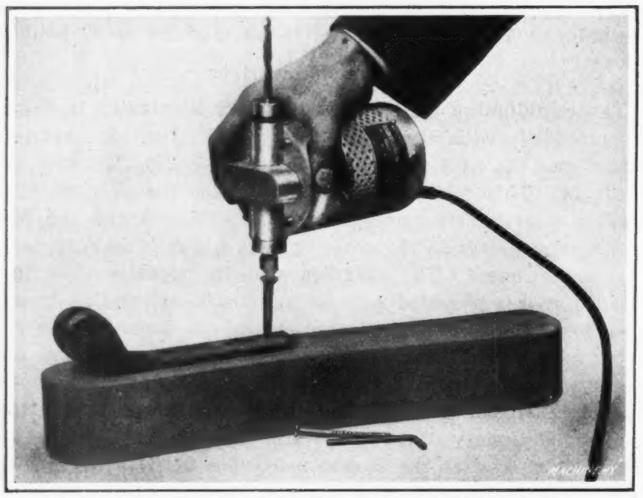


Fig. 2. Automatic Electrical Tool Co.'s Combination Drill and Screwdriver

is taken by a ball bearing located inside the gear case. These drills are fitted with a plug to enable them to be mounted in the spindle of a radial drill, thus making the equivalent of a drill speeder. The terminal block is located on the out- this type in 14-, 16, and 18-inch s'zes are equipped for cutting quickly made.

"CISCO" METRIC QUICK-CHANGE GEAR-BOX

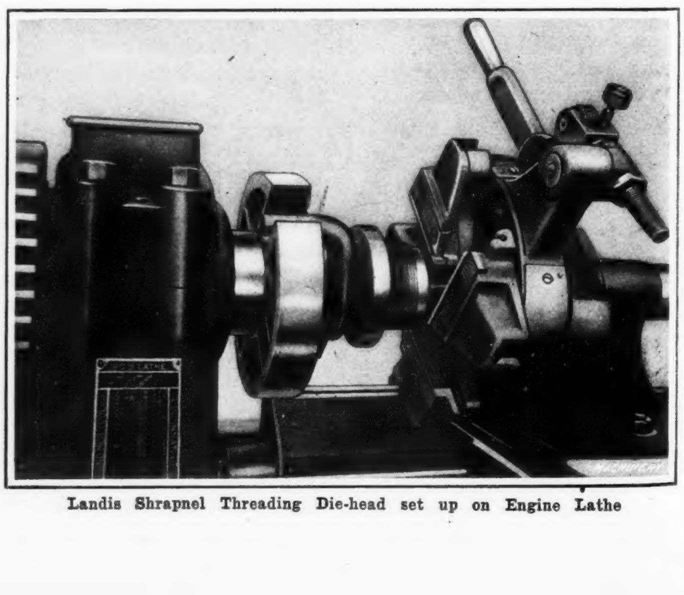
The head end of a "Cisco" lathe manufactured by the Cincinnati Iron & Steel Co., Cincinnati, Ohio, is shown in the illustration which accompanies this description. Lathes of this type in 14-, 16-, and 18-inch sizes are equipped for cutting metric pitches, the range being as follows: 12, 11, 10, 9, 8, 7, 6, 5.5, 5, 4.5, 4, 3.5, 3, 2.75, 2.5, 2.25, 2, 1.75, 1.5, 1.375, 1.25, 1.125, 1, and 0.875. These are obtained through a quick-change gear-box, all changes being obtainable without the necessity of transposing gears. Instead of having the reverse mechanism in the headstock, it is incorporated in the gear-box where it is within easy reach of the operator. In all other details the

"Cisco" Lathe equipped with a Metric Gear-box

construction and operation of the metric lathe is the same as that of the standard lathes manufactured by the Cincinnati Iron & Steel Co.

LANDIS SHRAPNEL-THREADING DIE-HEAD

The accompanying illustration shows a stationary type of die-head recently developed by the Landis Machine Co., Inc., Waynesboro, Pa., for use in threading the base and fuse plugs for shrapnel shells. This die-head is manually operated by means of a bellcrank lever and is locked in the closed position. The parts of the tool are made of steel and it is of compact and durable design. The use of Landis long-life chasers insures accuracy of the work, together with economical operation and a high rate of production. The chasers may be furnished with short throats or without throats so that it is possible to cut a full thread right up to the head of the plug. The accompanying illustration shows the die-head attached to an engine lathe, the connection being made by bolting the die head to a bracket, which, in turn, is supported on the cross-slide guides. The die-head may also be equipped with a shank to provide for using it on turret lathes.



Landis Shrapnel Threading Die-head set up on Engine Lathe

DOUBLE-ACTING SPEED CONTROLLER

The double-acting speed controller which forms the subject of this description is a precision governor that has been designed and placed on the market by the Speed Controller Co., Inc., 257 William St., New York City, for the purpose of regulating the speed and power consumption within very narrow limits. It is adapted for use in connection with either electrical or other power systems, although the operation of the instrument itself is purely mechanical. It is equipped with two shafts, one of which is a high-speed governor shaft which runs continuously at the desired speed and is driven by the power which it is required to control; the other is a secondary shaft which is stationary when the governor shaft is revolving at the proper speed, but which rotates in either the forward or reverse direction when the speed of the governor shaft rises or falls from the desired point. The secondary shaft is geared to a valve, rheostat or other power regulating device, and continues its motion in the proper direction until the speed of the governor shaft has been restored to normal condition. When this result has been obtained, the secondary shaft comes to rest.

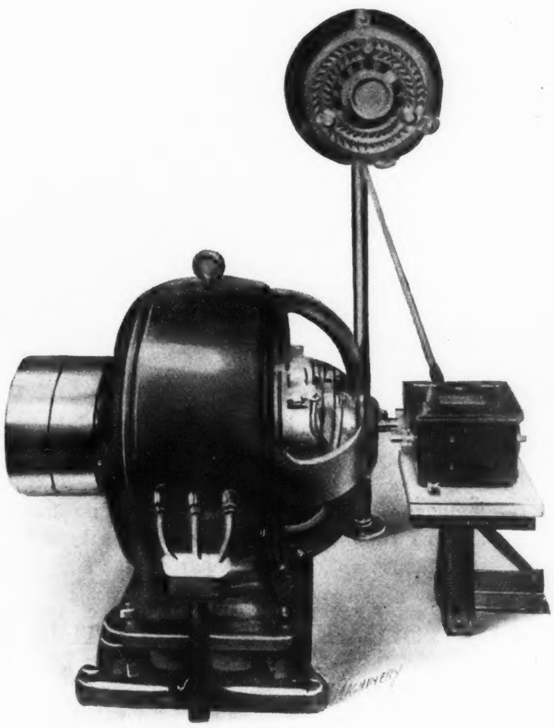


Fig. 1. Application of Speed Controller in Connection with Electric Motor

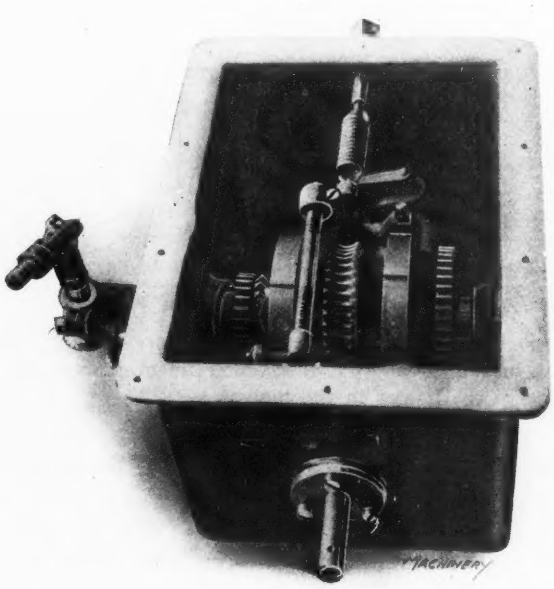


Fig. 2. Mechanism of Speed Controller

RESULTS OF TESTS TO DETERMINE SENSITIVENESS OF CONTROLLER*

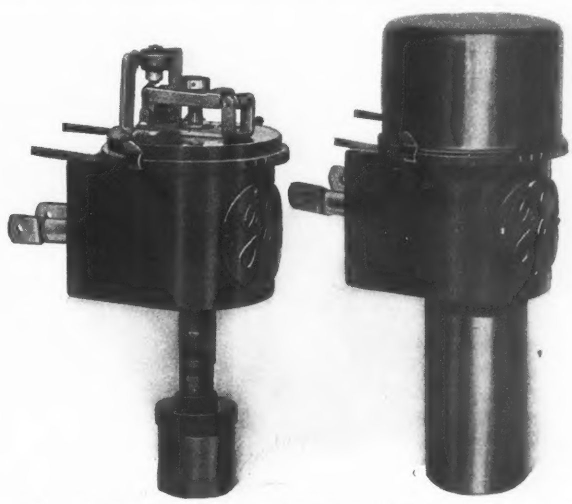
Motor Speed	Variation in R. P. M. each Side of a Given Setting	Total Variation in R. P. M.	Per Cent of Variation Either Way	Total Per Cent of Variation
2230	10.00	20.00	0.45	0.90
2100	8.75	17.50	0.42	0.83
1560	7.50	15.00	0.48	0.96

*Note: No load and full load results are the same.

When the speed controller is connected to the field rheostat of a motor, the speed of the motor will be kept within a maximum limit of variation of about 0.83 per cent or about 0.42 per cent either way from the normal speed which is desired. If this variation of 0.42 per cent from the normal speed is too small, a wider variation or "neutral zone" is provided for by a suitable adjustment. The speed is controlled to exactly the same point whether the motor is under full load or under no load, and whether the field windings are either cold or warm. The controller may be used either direct or as a relay according to the conditions. While emphasis has been laid upon the application of the instrument to electrical installations, it is equally serviceable on steam engines, hydraulic machines and similar units. The table presented in this connection shows the results of a test of the instrument in which speed readings were taken with a Horn tachometer.

G. E. COMPENSATOR TYPE RELAY

A new type of circuit-opening inverse-time-limit oil-dashpot relay has recently been developed by the General Electric Co., Schenectady, N. Y., for use in conjunction with a low-voltage release for automatic, overload and low-voltage protection of alternating-current motors up to 2500 volts and 300 amperes. The relay is connected in series with the line, the low-voltage release across one phase in the usual manner with the low-voltage coil in series with the relay contacts. On overload greater than the current setting the relay, the relay contacts open-circuit the low-voltage release coil and the motor is cut out of the circuit. If the voltage drops to a predetermined per cent of normal, the motor is also disconnected from the power supply.



Series Inverse Time-limit Overload Type of Relay made by the General Electric Co.

This relay is mostly employed with motors using self-contained compensator control, but sometimes for switchboard service when both low-voltage and time-delay overload protection are required. Here series relays replace the secondary relays, current transformers and oil switch tripping coils otherwise required. Current calibration is from normal to twice normal, and the time adjustment from 10 seconds to 5 minutes on 25 per cent overload. The delay recommended, however, is about 15 seconds at the starting current of the motor. This affords ample protection to the

motor against damage from overload or single-phase operation, but prevents the circuit from being opened while the motor is starting. The new relay is a vast improvement over the one previously manufactured. The contact, dashpot and calibrating tube are enclosed by dust-proof stamped steel covers. Current and time adjustment are accomplished outside of the dashpot simply with the aid of a screw-driver. The settings are constant, for an adjusting nut is locked in place after each setting is made.

LOWE "LAST WORD" INDICATOR

In the March, 1914, number of MACHINERY the "Last Word" dial test indicator manufactured by Henry A. Lowe, 1374 E. 88 St., Cleveland, Ohio, was illustrated and described. Those who read the description referred to will recall that this indicator is a simple and relatively low-priced instrument with a capacity for readings from zero to 0.025 inch. Fig. 1 shows an improved instrument of similar design which has recently been placed on the market by the same manufacturer. It will be seen that the present tool has a greater range, the capacity being from zero to 0.040 inch.

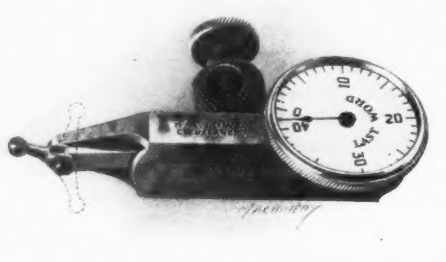


Fig. 1. H. A. Lowe Model B Dial Test Indicator

Another noteworthy improvement is that a friction joint is provided at the pivot of the contact point so that this point may be set in any position through an angle of 210 degrees, allowing the instrument to be used with equal facility on both inside and outside work, and in many positions which were not attainable with the original form of indicator in which the position of the point is fixed. The arrangement of the lever system in the indicator is such that the ratio is approximately 60 to 1. Fig. 2 illustrates the Model C indicator which is

Fig. 2. Model C Dial Test Indicator made by H. A. Lowe

the only one of the Lowe "Last Word" indicators that is provided with an adjustable dial. The Model C instrument also has the friction joint adjustment for the contact point.

JOHNSON & CRUMP SURFACE FILE AND SCRAPERS

The Johnson & Crump Co., 413 W. Crawford St., Elkhart, Ind., is now manufacturing the surface file handle and the scrapers for internal and flat work, which are shown in the accompanying illustrations. Fig. 1 shows the handle for holding a file while working on flat surfaces, angles and under-cuts. It will be evident that this handle is provided with a clamp which grips the shank of the file without touching the surface of the work. As a result, the handle does not interfere with the work and the whole file surface is available, thus enabling the work to be done rapidly.

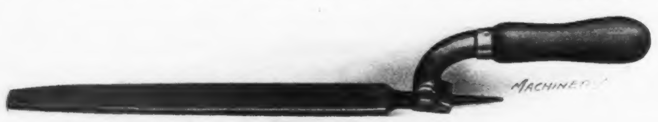


Fig. 1. Johnson & Crump Handle for a Surfacing File

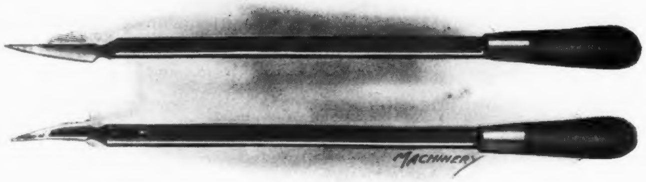


Fig. 2. Opposite Sides of Internal Scraper made by the Johnson & Crump Co.

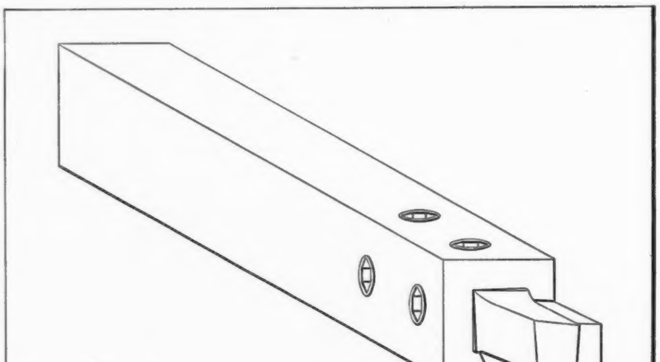
Fig. 2 shows opposite sides of a scraping tool for use on internal work. It will be seen that the scraper shank is held in a slot cut in the end of the holder, and that the scraper is further supported by a dovetail which is fitted to the end of the holder. The scraper is held in place by two countersunk screws. The scraper blades are made of a special grade of tool steel which will hold its edge satisfactorily,

Fig. 3. Scrapers for Flat Surfaces fitted into Handle shown in Fig. 2

while the holder is made with sufficient spring to give the blades a shearing cut. Fig 3 shows the same type of holder provided with blades for scraping flat surfaces.

READY TOOL-HOLDER FOR STELLITE CUTTERS

The tool-holder for stellite cutters which forms the subject of the following description is the latest product of the Ready Tool Co., 654 Main St., Bridgeport, Conn. This holder is adapted for use in a boring mill or vertical turret lathe and is capable of holding a square stellite cutter 6 inches in length, which can be used up with not more than 1 inch of waste. The cutter is perfectly supported on the bottom and at the back, the construction being such that the required degree of rigidity is obtained and all danger of the cutter being broken is eliminated. Another desirable feature of this tool-holder is that by turning it through one quarter revolution, the tool can be adapted for operation in either a right-hand or left-hand position, with the proper clearance and



Ready Tool-holder especially adapted for using Stellite Cutters

side slope in either direction. The stellite cutter is held in place by hollow set-screws which offer no obstruction to the mounting of the holder in the toolpost.

HISEY-KING GUARD FOR VISE JAWS

To protect vise jaws from damage while working on a piece held in them, the Hisey-King Mfg. Co., Osgood, Ind., has recently developed a set of auxiliary jaws made of hard wood, which not only protect the jaws of the vise from injury but also prevent marring the surface of the work itself. It

Application of Hisey-King Vise Jaw Guard

is stated that the first experience which a mechanic has with the use of these jaws affords a surprise both in regard to the secure grip which is provided on the work and the length of time which the jaws last. Another claim made is that the vises will last longer because the tenacious grip of the wooden jaws on the work makes it unnecessary to tighten them to the degree which would otherwise be necessary. The general construction will be readily understood from the accompanying illustration; the jaws are made in two sizes which are 3 and 4 inches in width, respectively, and they have a capacity for opening from zero to 1¼ inch.

FRITZ "IDEAL" DRAWING TABLE

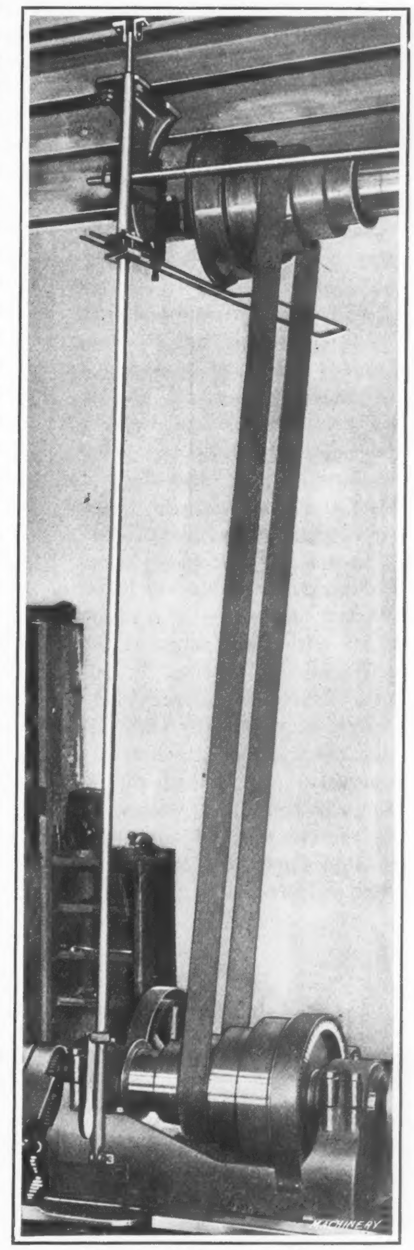
The style E "Ideal" drawing table which forms the subject of the following description is a recent addition to the line of drafting-room furniture made by the Fritz Mfg. Co., 60 Alabama St., Grand Rapids, Mich. A careful study of the illustration will make it evident that the features of strength and rigidity are provided without making the table excessively heavy, this result being obtained by a carefully worked out design in which all of the members are made to carry their full share of the load. This table has been particularly developed to meet the requirements of the drafting-rooms in manual training and technical schools, but it is also used in the drafting-rooms of many manufacturing plants.

Style E "Ideal" Drawing Table made by the Fritz Mfg. Co.

The frame is made of hard wood. The standards are slotted and the cross-bar has a tenant on each end which runs in the slots cut in the standards. The cross-bar also has a hole running through it which carries a rod that holds on the legs at each side. When the nut is tightened on this rod, the table is firmly supported without any vibration. These tables are made in four sizes with working areas of 22 by 30 inches, 24 by 32 inches, 32 by 42 inches, and 37 by 48 inches. On the two smaller sizes the table can be adjusted to any position between 30 and 40 inches from the floor, while the two larger sizes of tables can be set in any position ranging from 32 to 42 inches from the floor. The table top can be set at any angle from vertical to horizontal, this adjustment being accomplished by means of metal slides at each side, which can be clamped to secure the table top in the desired position. Both of the slides are clamped by tightening the thumb-nut at the right-hand side of the table. These tables are regularly furnished with soft wood tops, but the smallest size can be furnished with a hard wood top if so desired.

ALEXANDER & COX BELT SHIFTER

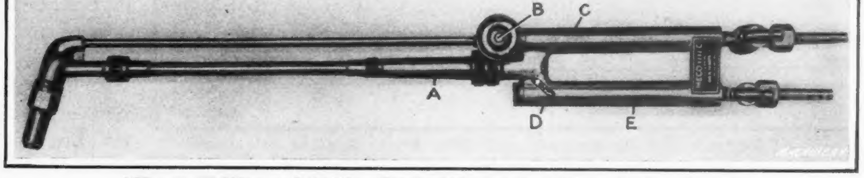
The loss of time and possibility of accident incident to the use of a pole for shifting belts from one step of a cone pulley to another, is too well known to require discussion. Various forms of mechanical belt shifters have been developed for the purpose of overcoming the objectionable features of the belt pole, and the accompanying illustration shows the device which has recently been perfected by the Alexander & Cox Co., 2358 Ogden Ave., Chicago, Ill. It is known as the "Acme" belt shifter and should commend itself to practical mechanics owing to the fact that only four screws are required to attach it in place ready for use. The method of operation will be obvious from the illustration, the shifting of the belt being effected by turning the hand-lever which is located in a convenient position at the head of the lathe; this results in swinging the shifter fork in the proper direction to move the belt onto the desired step of the cone. This belt shifter is equally applicable for use on various other types of machines.



Alexander & Cox Belt Shifter

MODERN CUTTING AND WELDING TORCH

In designing the "Meco" cutting and welding torch, the Modern Engineering Co., 14th and St. Charles Sts., St. Louis, Mo., has paid particular attention to safeguarding the operator from possible injury through the gas burning



"Meco" Welding and Cutting Torch made by the Modern Engineering Co.

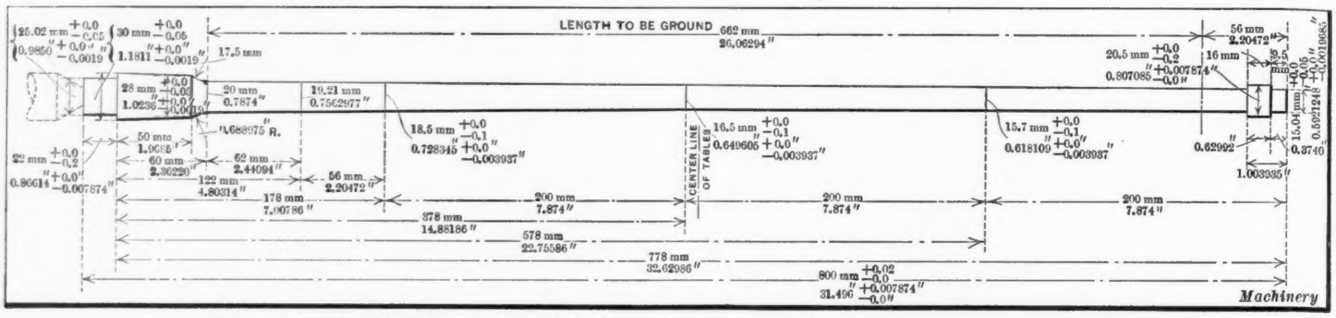


Fig. 1. Outside Dimensions of French Military Rifle Barrel showing Tapered Sections to be ground

back into the hose. This safety feature is afforded by a patented check valve system in both gas conduits which absolutely prevents either the oxygen or acetylene from flowing into the passage through which the other gas is being delivered to the tip of the torch. Another feature is that the handle is cast in a single piece and made of a special alloy which is said to be stronger than brass and lighter in weight than aluminum. All tips used on the "Meco" torch are equipped with a patented protected seal between the tip and the head of the torch which insures a perfect union and prevents leakage or damage to the torch if it is roughly handled.

The mixing chamber is made of bronze and is so designed that the gases are combined to produce an absolutely neutral flame with a temperature exceeding 6300 degrees F. It is also claimed that the consumption of gas by the torch is unusually low. The tips are furnished in various sizes suitable for handling all classes of work which come within the range of the oxy-acetylene process. A cutting attachment is provided for use with the welding torch, which may be easily and quickly applied. The work of securing the cutting attachment in place consists of two simple operations; the nut on the oxygen valve and the union nut on the gas conduit are removed, which makes the torch ready to receive the cutting attachment. The accompanying illustration shows the torch equipped with the cutting attachment. The universal mixing chamber is shown at *A*, the thumb controlled needle valve for the cutting jet at *B*, the automatic check valve system at *C* and *D*, and the one-piece handle at *E*.

CINCINNATI RIFLE BARREL GRINDING MACHINE

The barrel of the French military rifle is finished on the outside with five tapered sections, the dimensions of which—together with the other outside dimensions of the barrel—are shown in Fig. 1. These dimensions are given in millimeters in accordance with French shop practice, but the metric values have been converted into inches for the convenience of MACHINERY's readers. For finishing the outside of rifle barrels, the Cincinnati Grinder Co., Cincinnati, Ohio, has recently built grinding machines for use in one of the French arsenals, which have given very satisfactory results. These machines are essentially the same as the universal Cincinnati grinding machine which was illustrated and described in the October, 1910, number of MACHINERY. Provision for grinding rifle barrels was made by the application of a fixture to the universal grinding machine, the fixture being fitted with five templets which are tapered to match the corresponding tapers which it is required to grind on the work.

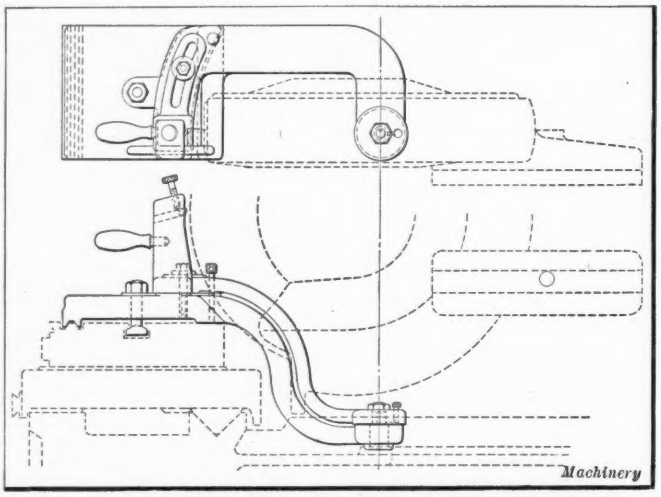


Fig. 2. Wheel Truing Device used in connection with Rifle Barrel Grinding Attachment

A partial plan view of the rifle barrel grinding fixture is shown in Fig. 3. The essential parts of the fixture consist of a bracket *A* which is bolted to the frame of the grinding machine, and a second bracket *B* which is secured to the table. The bracket *A* carries the five templets *C*, *D*, *E*, *F* and *G*, which have tapers corresponding to the tapers required to be ground on the work. These tapered templets are engaged by the rollers carried by the bracket *B*, positive engagement between the rollers and templets being insured by a spring (not shown) which is carried in the socket *H*. It will be evident that as the wheel moves over the rifle barrel which is to be ground, the engagement of the rollers with the tapered templets on the fixture results in so moving the grinder table that the required tapers are obtained on the work.

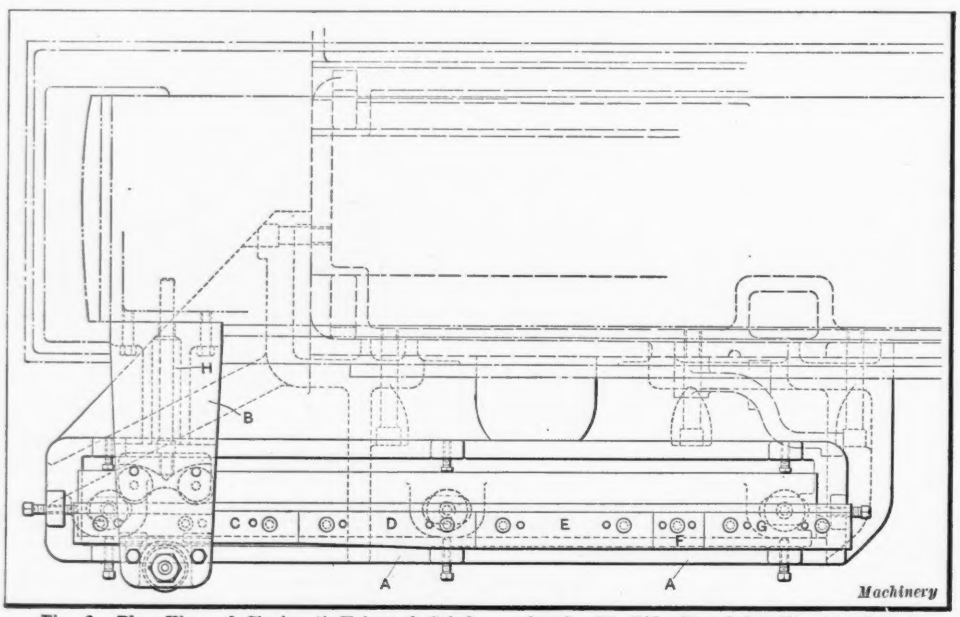


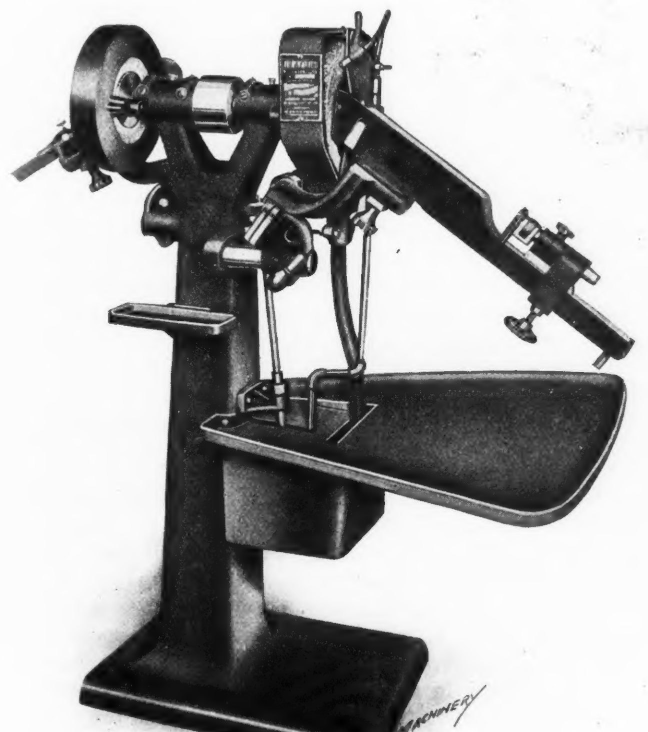
Fig. 3. Plan View of Cincinnati Universal Grinder equipped with Rifle Barrel Grinding Attachment

In order to provide for continuous traverse of the work over the wheel, it is necessary to have the face of the wheel trued to a circular arc. The reason for this is

that if the face of the wheel were straight, the corner would dig into the work at each point of intersection between adjoining tapers, and this would destroy the finish. But difficulty from this source is completely overcome by the use of the wheel truing device shown in Fig. 2, which is mounted on the table of the machine and provides for truing the wheel to a curve so that, theoretically, there is only a single line of contact between the wheel and work. As a result, the wheel comes up to the intersection of adjoining tapers and passes on to grind the surface of the next taper without damaging the surface. In grinding rifle barrels on this machine, a table traverse of from 26 to 30 inches per minute is employed with a work speed of 100 feet per minute.

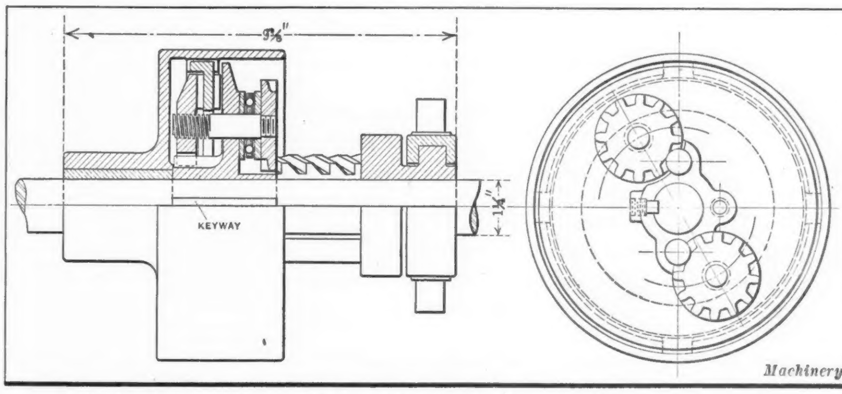
IMPROVED WILMARTH & MORMAN DRILL GRINDER

All experienced mechanics are familiar with the general features of the "New Yankee" drill grinder manufactured by the Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich., so that it will only be necessary to refer to the improved features of the machine which is illustrated and described herewith. Two noteworthy changes have been made in the design. One of these consists of the provision of a larger sized pan which prevents water from being thrown onto the floor. After the pump has delivered the water to the work, that portion which formerly flowed down the drill-holder and was carried away by a flexible vent pipe now runs from the short outlet into the pan, from which it finds its way back to the reservoir. Inside the reservoir there is a separator plate extending almost to the surface of the water. The water returning to the reservoir finds its way in at one side of this plate while the pump takes its supply from the opposite side. As a result, abrasive dust, grindings or other foreign materials are prevented from finding their way into the pump. The other improved feature of the machine referred to consists of the substitution of bronze-bushed spindle bearings in place of the babbitt bearings formerly employed.



Wilmarth & Morman Improved "New Yankee" Twist Drill Grinder, with Large Raised Pan and Bronze Bushed Spindle Bearings

HILLIARD 6-INCH MACHINERY CLUTCH

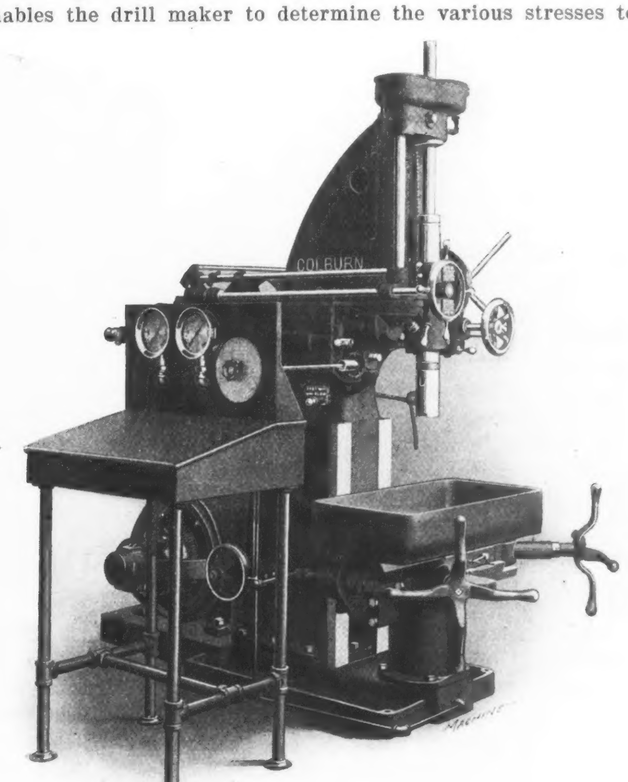


Hilliard 6-inch Machinery Clutch with Woven-wire and Asbestos Friction Rings

In the February, 1915, number of MACHINERY, the friction clutch manufactured by the Hilliard Clutch & Machinery Co., Elmira, N. Y., was illustrated and described. Recently the same firm has developed a clutch of similar design with the exception of the fact that two solid woven-wire asbestos rings are used for the friction material in place of the hard wood friction inserts employed in the type of clutch previously described. The use of the woven-wire asbestos rings was adopted to utilize waste material cut from the Hilliard automobile clutch linings. The result is very satisfactory, as the new frictional contact is superior to that obtained with hard wood, and its use enables a profitable outlet to be found for material which would otherwise go to waste. In their general characteristics the present clutch and the clutch described in the February, 1915, number of MACHINERY are the same, so that further description would be out of place. The chief point of difference is that the use of the woven-wire asbestos rings has made it necessary for the friction plate to which they are riveted to float on four driving keys which are integral with the outer sleeve member.

COLBURN TWIST DRILL TESTING MACHINE

The testing of twist drills on a special drill testing machine is an important factor in the process of manufacture, as it enables the drill maker to determine the various stresses to



Special Drilling Machine built by the Colburn Machine Tool Co. for Use in testing Twist Drills

which his product will be subjected when drilling different kinds of metals under various conditions of speed and feed. The results obtained from such tests also make it possible for the drill manufacturer to recommend the best speed and feed for different sizes of drills when working under various conditions.

The illustration on the preceding page shows a heavy-duty drill press built by the Colburn Machine Tool Co., Franklin, Pa., for the National Twist Drill Co. of Detroit, for testing twist drills. The machine is one of the Colburn standard motor-driven heavy-duty drill presses equipped with a specially designed compound table which registers the torque and pressure on the drill while it is in operation. The speed of the drill in revolutions per minute, and the feed per revolution, are also indicated. The table has both longitudinal and cross travel, and is carried on a large spindle having both annular and thrust ball bearings which allow it to revolve freely. The spindle rests on a plunger that fits into a cylinder filled with glycerine, the connection being made from this cylinder to the hydraulic pressure gage located at the left-hand side of the instrument board. Any pressure on the drill is thus indicated on the gage.

An arm projecting from the left-hand side of the spindle engages another plunger that fits into a cylinder filled with glycerine, which is connected to the hydraulic pressure gage at the right-hand side of the instrument board. Any torque exerted on the drill tends to revolve the table; this causes the arm to press against the plunger, and thus sets up a pressure which registers the amount of torque on the second gage. The plunger is 14 inches from the center of the spindle, and in order to find the actual torque on the drill it is necessary to multiply the pressure indicated by the gage by 28, and divide this result by the diameter of the drill. For example, if the gage registers 500 pounds when drilling with a 2-inch drill, then the actual torque on the drill would be $\frac{500 \times 28}{2} = 7000$ pounds.

A tachometer mounted at the extreme left of the instrument board and connected to the machine by a spring belt, shows the revolutions per minute of the drill at all times. The feed per revolution of the drill is shown on the feed plate at the right-hand side of the instrument board; thus a man standing at the desk in front of the instrument board can read the speed in revolutions per minute, the feed per revolution, torque, and pressure in pounds on the drill. The use of this machine has enabled a lot of interesting data to be collected, such classes of information being obtained as the manner in which the stress in the drill varies for different depths of holes and different lengths of time between grinding.

LANGELIER HIGH-SPEED SENSITIVE DRILL

The machine illustrated and described herewith is a recent product of the Langelier Mfg. Co., Providence, R. I., and has a capacity for drilling holes up to ⅛ inch in diameter at the center of a 6-inch circle, with a spindle speed of 9000 revolutions per minute. This is a ball bearing drill of the single-speed type. A substantial guard is provided at the front of the spindle which protects the operator and prevents oil being thrown from the machine. It will be seen that the spindle is driven direct by an open belt from a pulley at the upper end of a vertical shaft at the rear of the machine which, in turn, is positively driven by spiral gears which make connection with a horizontal shaft on which the tight and loose pulleys are mounted. The machine has a capacity for work or jigs up to 6½ inches in height and the table has a working surface of 4¼ inches deep by 7 inches wide. The maximum spindle travel is 2 inches. A threaded depth gage with a hardened and knurled screw head and side locking screw provides for adjusting the main depth gage very accurately.

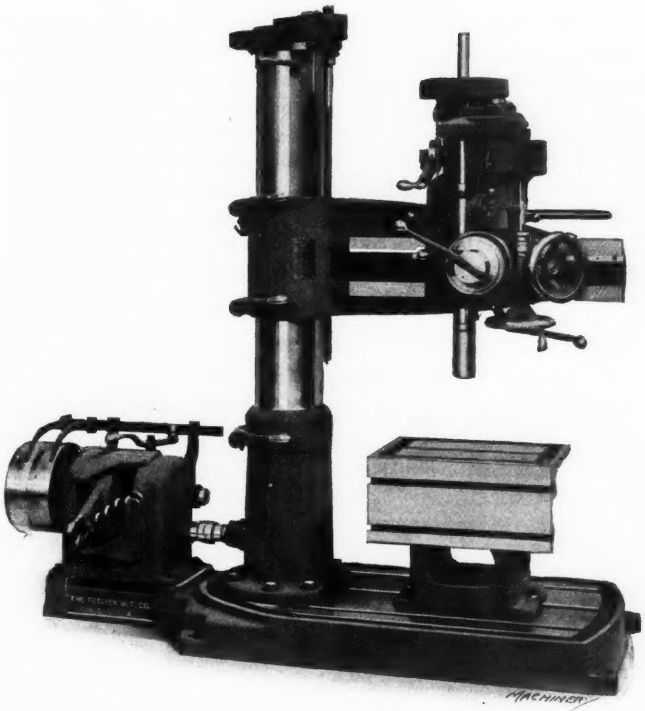
The spindle is made of hardened steel and ground to size; it is double splined to provide perfect balance under the high speed at which the machine is used. The lower end of the spindle is tapered to fit the socket of a No. 0 Beach chuck made by the Morse Twist Drill Co., which has a capacity for holding all sizes of drills from the finest up to ⅛ inch in diameter. The lower portion of the spindle runs in hard phosphor-bronze bearings which are made adjustable to compensate for all normal wear likely to occur; and the thrust of the drill is taken at the upper end of the spindle by means of a combination thrust and radial bearing. A coiled spring keeps the spindle raised from the work when the machine is idle, this spring being located inside the column of the machine. The strength of the spring is just sufficient to raise the spindle and bring it to a gradual stop so that no jar or vibration is introduced.

High-speed Ball Bearing Sensitive Drill made by the Langelier Mfg. Co.

The operation of the feed is made extremely sensitive by eliminating all direct pull from the spindle and by the arrangement of the feed mechanism. The spindle pulley is recessed and in this recess there are mounted two radial ball bearings. The outer races of these bearings are a creeping fit in the pulley and revolve with it while the inner races are mounted on a fixed hard phosphor-bronze sleeve which is clamped securely in the drill frame spindle bearing. As a result all belt pull is carried by this sleeve while the spindle which passes through it is entirely free from pull at all times. A hardened steel cap closes the open end of the spindle pulley and encases the ball bearings to exclude dust and grit. The driving belt is an endless woven canvas belt 1 inch in width. The sensitiveness of the feed is obtained by having the pinion which is operated by a hand lever mesh into a rack cut on the back of the drill spindle frame, but not directly into a rack mounted on a feed sleeve around the spindle. In this way the slightest resistance offered to the progress of the drill is instantly communicated to the operator's hand and the feed can be eased off to avoid breaking the drill.

FOSDICK MANUFACTURING RADIAL DRILLS

The Fosdick Machine Tool Co., Cincinnati, Ohio, has recently developed a line of radial drilling and tapping machines which are known as the Fosdick high-speed manufacturing radial drills. The first two sizes to be placed on the market are provided with 2- and 2½-foot arms, respectively, and are intended to meet the demand for high-speed durable machines which are capable of handling a great variety of work—especially in shops where unskilled labor is employed. It will be apparent from the illustration that the design of these machines follows closely along the lines of the Fosdick heavy-duty radials which have been illustrated and described



Fosdick High-speed Manufacturing Radial Drill

in MACHINERY, the oil channel base and table, the double tubular column, and the speed-box being identical on both types.

Provision is made for forty-eight rates of drilling which cover a range suitable for drilling with from 3/16 inch carbon-steel up to 2½ inch high-speed steel when working in iron and steel; and for boring holes up to 5 inches in diameter. All these rates of drilling are obtained with but one speed at the pulley. Particular care has been taken in the selection of materials used in the construction of these machines. The bushings are of a special grade of phosphor-bronze, and all gears subjected to severe duty are cut from steel forgings and hardened where necessary. In cases where the speed is high or the duty light, the gears are made of cast iron or bronze. The spindle and principal driving shafts are made of hammered steel; and the thrusts of the column, spindle and arm-elevating screw are carried on ball bearings. The column and shafting are finished by grinding.

Thorough tests of these machines have been made at the works of the Fosdick Machine Tool Co., using high-speed steel drills up to 2½ inches in diameter working in both machine steel and cast iron. In one case a 1-inch high-speed steel drill was driven through a cast-iron slab 2 inches in thickness in 7 4/5 seconds, *i. e.*, at the rate of 15.4 inches per minute; the speed was 550 R.P.M. and the feed 0.028 inch per revolution. In another case a 2½-inch drill was driven through 1½ inch of machine steel at various rates ranging from a speed of 137 R.P.M. and a feed of 0.007 inch per revolution, to a speed of 49 R. P. M. and a feed of 0.028 inch per revolution. The 2-foot machine will drill to the center of a 48-inch circle at the base, which has a working surface of 26 by 31 inches. The 2½-foot machine will drill to the center of a 60-inch circle at the base, which has a working surface of 28 by 36 inches.

The following dimensions apply to both machines: distance from base to spindle, 51 inches; spindle traverse, 12 inches; minimum diameter of spindle; 1 9/16 inch; bore of spindle, No. 4 Morse taper; and net weight of machines, 2900 and 3200 pounds, respectively. As in the case of the Fosdick heavy-duty radial drills, the interchangeable drive has been adopted, *i. e.*, a cone-driven machine may be changed over to speed-box drive, or *vice versa;* or a constant or variable speed motor may be employed to drive the machine at any time after it has been placed in service, without the necessity of providing a special base, speed-box, shafts or gearing. Tilting, swinging or round tables of the standard types supplied with other Fosdick radial drills may be furnished on this machine as desired.

CLEVELAND SHELL BANDING AND NOSING PRESS

For use in nosing shrapnel and high-explosive shells in sizes up to the 18 pound and for pressing the copper bands on shells up to the 60-pound size, the Cleveland Crane & Engineering Co., Wickliffe, Ohio, is now making an air-operated press, the design of which is shown in the accompanying illustrations. The press is of simple design and rigidly constructed to enable it to stand up under severe service. The method of operation is as follows: Air at a pressure of 100 pounds per square inch is admitted to the cylinder *A;* the piston in this cylinder is 27 63/64 inches in diameter and has a lift of 2¼ inches. Six lugs *B* are cast to the top of the piston and these lugs carry the links which operate the toggles *C*.

The outer ends of the toggles are held by a fixed ring while their inner ends actuate the plungers which compress the copper band onto the shells. It will, of course, be evident that when air is admitted to the cylinder at *E*, the piston rises and the toggles force the plungers in against the work. Referring to the plan view, it will be seen that the shell on which the band is to be compressed occupies a vertical position in the space *G* between the six plungers. Two settings of the work are necessary, the shell being turned through an angle of 90 degrees after the first pressing operation has been performed. The rate of production on 18-pound shells can be maintained at 200 per hour.

Fig. 1. Cleveland Crane & Engineering Co.'s Press equipped for pressing Band on Shell

The same press provides for performing the nosing operation. For this purpose a housing *H* is bolted to the top of the frame and an auxiliary plunger *J* is placed on top of the main piston. The top of the plunger *J* is recessed to fit the particular size of shell which is to be nosed, and when the piston rises, the shell is forced up into the die *K* which gives it the required form. It will be seen that the nosing die is bolted

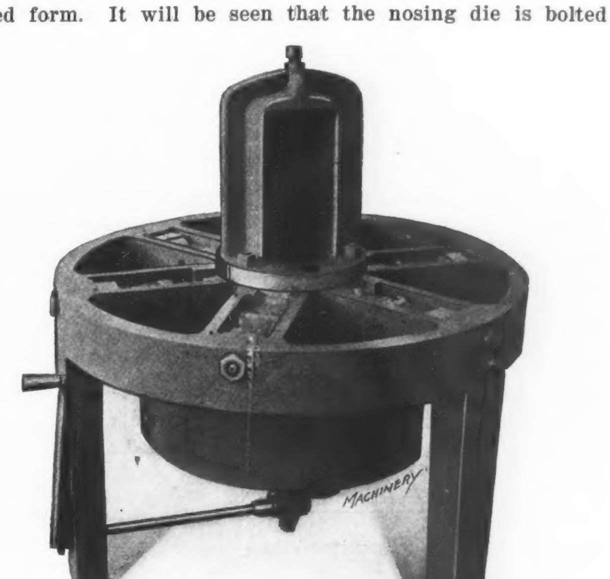


Fig. 2. Auxiliary Housing and Plunger in Place ready for Nosing Operation

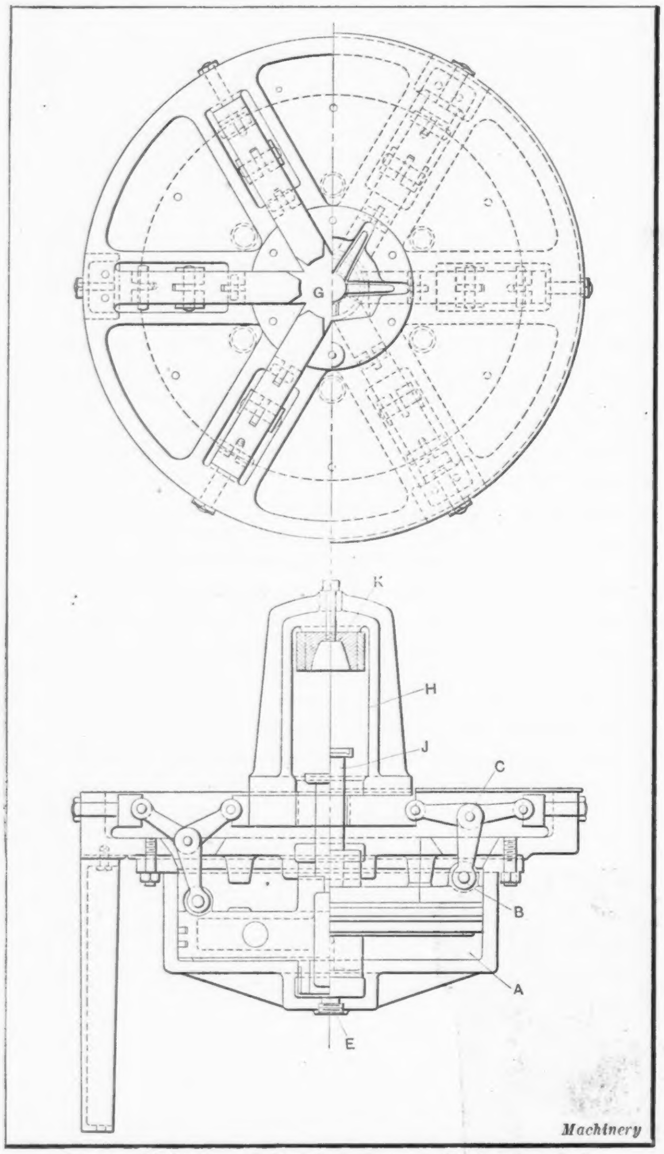
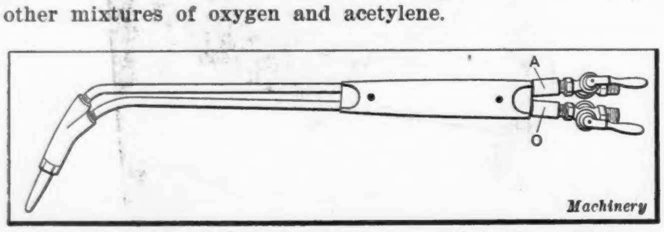


Fig. 3. Mechanism of Cleveland Crane & Engineering Co.'s Banding and Nosing Press

to the top of the housing; otherwise the operation of the press is the same as for the banding operation. The machine has a capacity for nosing shells up to the 18-pound size and the rate of production is 150 per hour. The same press can be used for marking shells by substituting a marking die in place of the nosing die.

FEDERAL WELDING TORCH

The "Federal" oxy-acetylene welding torch which is a recent product of the Federal Brass Works, 31st St. and Kedzie Ave., Chicago, Ill., is illustrated and described herewith. This is an equal pressure torch which is used in connection with regulators and gages to maintain a constant flow of the acetylene and oxygen. The claims made for this method of operation are a saving of 20 per cent in the amount of gases consumed, and the ability to handle a wider range of delicate work operating the torch with the gases at lower pressures than those which are normally employed. In this connection it is important to bear in mind that while the manufacturers of this torch recommend the use of an even mixture of gases, it can still be operated with a variety of other mixtures of oxygen and acetylene.



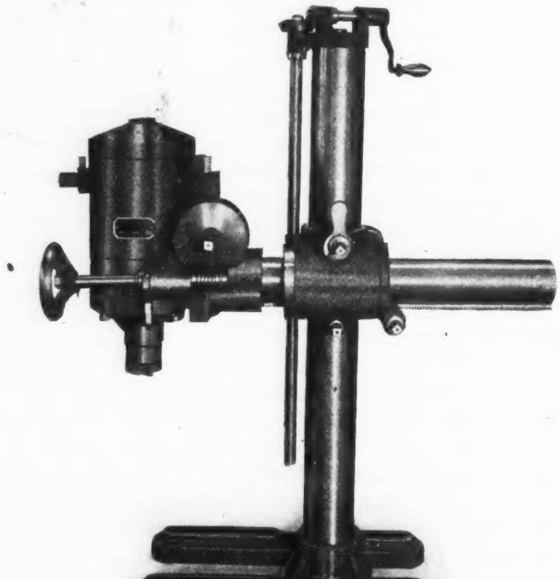
Oxy-acetylene Welding Torch made by the Federal Brass Works

The Federal welding torch has a nickel-plated mixing head of patented construction, and a light weight polished aluminum handle which is designed in such a way that it will not become uncomfortably hot. The torch is equipped with two straight-handled shut-off cocks, as shown in the illustration, where the acetylene cock is marked *A* and the oxygen cock *O*. These straight-handle cocks are so arranged that they can be closed almost instantly. The over-all length of the torch is 20 inches, and it is said to be exceptionally light and well balanced.

IMPROVED CINCINNATI PORTABLE RADIAL DRILL

The Cincinnati Electrical Tool Co., Cincinnati, Ohio, has recently made noteworthy improvements in the design of its portable radial drill, and the accompanying illustration shows the form in which tools of this type are now being built for the market. In general respects the design follows that of the portable radial drill of this company's manufacture which was illustrated and described in the April, 1910, number of MACHINERY; but probably the best way of explaining the improvements which have been made will be to give a general description, calling attention to the points where changes in design have been made.

It will be seen that the arm and knuckle have a vertical adjustment on the column by means of bevel gears and a lead-screw 34 inches in length. The crank handle which makes this adjustment is located in a horizontal position instead of being vertical, as on the original machine. This change was made to take advantage of the greater convenience of a horizontal handle. The revolving bearing in the knuckle which supports the cross-arm has a graduated collar to facilitate the making of accurate angular settings. The setting is made by means of a worm and worm-wheel in the knuckle, which enables the drill head to be set to any angle and held in that position until clamped. Formerly a simple



Portable Radial Drill made by the Cincinnati Electrical Tool Co.

clamp was used which made it necessary for the head to be held in place until clamped. The head can be set at any angle and has a circle radius of 24 inches; a maximum feed of 10 inches is provided through a handwheel, and quick return is also provided. An improvement has been made in this mechanism by allowing the handwheel to be used in either a horizontal or vertical position, the latter setting being convenient when it is required to get into close corners.

All gears are made of heat-treated steel and are mounted on ball bearings in an independent gear-case located at the end of the motor housing. The gears run in grease. Annular ball bearings are used at both ends of the armature shaft

and the spindle thrust is taken by a ball thrust bearing. The grease in the gear-case also serves as a lubricant for the annular and thrust bearings which carry the spindle, and also for the ball bearing at the lower end of the armature shaft. This is accomplished by the provision of suitable ducts through which the gears force the lubricant to the required positions. A threaded brass plug at the top of the case makes it an easy matter to renew the lubricant when necessary. The switch employed on these tools is of a special design developed by the Cincinnati Electrical Tool Co.; it is of the quick make-and-break type, and insures immediate and positive contact. The drills are equipped with a special type of Morse-taper slip-socket and the use of a drift key in the spindle is done away with. The motor is air-cooled.

NEW MACHINERY AND TOOLS NOTES

Combination Scale and Truck: National Scale Co., Chicopee Falls, Mass. A combination elevating transfer truck and scale which enables material to be weighed while it is on the truck. The truck is of the usual elevating type used in connection with loading platforms. The truck is made in four different sizes.

Portable Shop Crane: La Salle Machine & Tool Co., La Salle, Ill. This crane is mounted on an electrically-driven truck and is provided with a compensating quadrant. The capacity is for lifting pieces up to 1000 pounds in weight. The compensating mechanism on the crane allows the suspended load to be moved out or in on a line parallel to the floor.

Vertical Milling Machine: Rockford Milling Machine Co., Rockford, Ill. This concern is now equipping its No. 1½ plain back-geared cone miller with a vertical head and circular table. The table used is 12 inches in diameter and is graduated in degrees. The vertical head is attached to the column, and the spindle is bored to take a No. 10 B & S taper shank.

Pipe Machine with Centralized Control: Crane Co., Chicago, Ill. In the design of this machine particular attention has been paid to the location of all control wheels and handles at a point where they are easily reached by the operator. This arrangement naturally gives increased production by making it unnecessary for the workman to leave the operating position.

Profile Grinding Machine: Fischer Machine Co., Philadelphia, Pa. A universal profile grinding machine for use in grinding irregular shaped cutters for metal work. The machine is equipped with a narrow edged formed wheel which is shaped by an eccentric truing device, and two parallel motion tables, one of which carries the cutter to be ground and the other the guiding templet.

Detachable Turret Head: Newman Mfg. Co., 717 Sycamore St., Cincinnati, Ohio. An auxiliary turret head attachment for use in the tailstock of engine lathes up to 24 inches swing. The use of this attachment converts an ordinary engine lathe into the equivalent of a turret lathe and materially increases the rate of production on classes of work where a series of tools is required. The turret has holes to accommodate four tools.

Circular Saw Guard: Crescent Machine Co., 56 Main St., Leetonia, Ohio. An adjustable saw guard which can be locked out of the way by means of a simple latch and pin device. The guard is made with lattice castings on each side so that the saw is visible at all times, and the adjustment makes it possible to vary the relation of the guard to its point of support in order to make it adaptable for use on all types of saw tables.

Ratchet Die-stock: Oster Mfg. Co., 2111 E. 61st St., Cleveland, Ohio. A die-stock with a capacity for piping ranging from 2½ to 4 inches in diameter. In operation, the tool is placed on the pipe and a small rod or piece of pipe is used to revolve the universal scroll chuck until the gripping jaws engage the pipe. The lead-screw is in position to thread when the slanting post which causes the dies to recede is flush with the face of the die-stock.

Single-purpose Turret Lathe: Cleveland Crane & Engineering Co., Wickliffe, Ohio. A single-purpose chucking turret lathe especially adapted for use in machining shrapnel and high-explosive shells in sizes ranging from 3 to 5 inches. The machine provides for performing the turning, drilling, boring and end-forming operations. It is of simple design and rigidly constructed to stand up under the severe service conditions which obtain in the manufacture of shells.

Shell Marking Machines: Brown-Boggs Co., Hamilton, Ontario, Canada. One of these is a machine for marking the base of a shell which is so arranged that the entire pressure of the machine is exerted on each individual letter and figure successively, so that a deep impression is obtained. The second machine referred to is a body marking machine in which the shell is rolled between a large disk and the die-holder. Each letter and figure may be adjusted to give a light or heavy impression as required.

Multiple Shell Turning Lathe: Jenckes Knitting Machine Co., Pawtucket, R. I. A multiple lathe designed for rough-turning five 3-inch shells at the same time. For this purpose the machine is equipped with five sets of centers located along the lathe bed, and the tailstocks are adjustable for shells of different lengths. Where exceptionally long work is handled, the number of pieces which can be turned simultaneously will necessarily be reduced. The machine has a range for work up to 6 inches in diameter.

Shell Banding Machine: Lourie Mfg. Co., Springfield, Ill. A hydraulic machine provided with six rams which are carried by a heavy steel ring. Each of these rams has a capacity for 100 tons pressure. The hydraulic pump has two differential pump barrels with large upper pistons for rapid movement of the rams and small lower pistons to provide the heavy pressure. The distance between opposing rams is 17 inches, and suitable dies can be furnished with the machine for working on shells from 3 to 12 inches in diameter.

Milling Machine: Ingersoll Milling Machine Co., Rockford, Ill. A combination horizontal and vertical machine which differs considerably from former models of this type of machine which have been built by the Ingersoll Milling Machine Co. The machine can be used as a horizontal or vertical machine, or both horizontal and vertical spindles may be used at the same time. The machine is known as the Ingersoll No. 3 combined high-power miller, and is arranged for constant speed from either a belt or motor.

Hand Screw Machine: Charles Stecher, Chicago, Ill. This machine is designed with a plain head, automatic chuck, wire feed, hand longitudinal feed to cut off, and independent stops. The automatic turret stops are easily thrown out at any time when it is desired to use either of the turret tools separately. In designing the machine particular attention has been paid to the development of a rigid construction. The regular equipment provided with the machine includes one front and back toolpost, a geared oil pump, a double friction countershaft and the necessary wrenches.

Lincoln Miller: American Machine Tool Co., Hackettstown, N. J. A milling machine particularly adapted for use in the manufacture of gun parts and similar work. It is a No. 1 size and has a 2½-inch spindle with a ¾-inch hole bored for a No. 10 B & S taper. The greatest distance from the spindle to the support in the tailstock is 18½ inches, the extreme distance from the headstock to the tailstock is 22½ inches, and the available spindle speeds are 16, 27 and 38 revolutions per minute. Eight changes of feed are available, ranging from 0.018 to 0.200 inch per revolution.

Single-purpose Lathes: Cincinnati Iron & Steel Co., Cincinnati, Ohio. Two single-purpose lathes which are adapted for shell work, the manufacture of automobile parts and various other classes of service where single-purpose machines are employed. The machines are built in two sizes, one for shells up to 6 inches in diameter and the other for shells ranging from 8 to 12 inches in diameter. They are of the geared-head single-pulley type, and are provided with four speed changes. The gear-box on the smaller machine gives five changes of feed ranging from 0.020 to 0.100 inch per revolution; on the larger machine there are six changes of feed ranging from 0.03125 to 0.375 inch per revolution. Various attachments are provided with the lathes which facilitate the performance of certain operations for which they are adapted.

Hand Milling Machine: Adams Co., 1904 Bridge St., Dubuque, Iowa. An improved form of the hand milling machine formerly built by this company, in which the same box form of table is retained but on which the vertical and spindle feed levers have been replaced by handwheels. The machine is particularly adapted for work on which it is required to make short quick cuts instead of profiling the work. If necessary, several strokes may be taken to complete the milling operation and the construction is sufficiently rigid to enable heavy cuts to be taken without chatter. The head has a vertical adjustment of 12 inches; the table is 8 by 18 inches in size and has a traverse of 18 inches; the spindle quill may be given a longitudinal movement of 2¾ inches; the spindle is bored for a No. 9 B & S taper; the floor space occupied is 3 by 4 feet; and the weight of the machine and countershaft is 980 pounds.

* * *

Garnet is an abrasive which varies widely in chemical composition and color, and which, applied to paper and cloth, is extensively used in the wood-working industries instead of sand paper. Garnet is found both in the massive state and in crystalline form, but it is only the crystalline garnet that is used as an abrasive.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

War as Affecting Contracts

(Federal) By the law of nations, all ordinary commercial intercourse between citizens of belligerents, being incompatible with a state of war between their countries, is absolutely interdicted. Where the law of both belligerent countries forbids a payment by a subject to a subject of the enemy country during the continuance of a war, such payment will not be enforced by a court of a neutral country, which has acquired jurisdiction of property of the debtor.

The United States District Court came to the foregoing conclusion in Watts, Watts & Co., Ltd., v. Unione Austriaca Di Navigazione. The Watts company is an English corporation, the Unione Austriaca, an Austrian company. Supplies consisting of machinery, coal and numerous other articles had been sold by the Austrian concern to the English company. Drafts were issued to cover the value of the property. The English company refused payment on the ground that a state of war existing between England and Austria discharged the obligation. The Austrian company thereupon brought this suit in the courts of the United States knowing that the English company had property here subject to execution. The District Court, however, held that where the law of both belligerent countries forbids a payment by a subject to a subject of the enemy country during the continuance of a war, such payment will not be enforced by a court of a neutral country, which has acquired jurisdiction of property of the debtor. *(Watts, Watts & Co. Ltd. v. Unione Austriaca Di Navigazione, 224 Fed. 188.)*

Oiling Machinery While in Motion Held Negligent

(Pennsylvania) An experienced machinist was not entitled to recover from his employer for injuries received while he was oiling a machine in motion and using an oil-can with a short spout, thus increasing the danger, though the machine was not guarded. *(Barrientos v. Brennan, 94 A. 927.)*

Waiver of Notice by Seller

(Oklahoma) Where a party purchases a piece of machinery under a contract which provides for a specific notice to be given the seller in case the machine proves unsatisfactory, held, that such notice is for the sole benefit of the seller, and may be waived by him. And, if waived by him, he cannot complain because the contract notice was not given. *(Continental Gin Co. v. Sullivan 150 P. 209.)*

Reliance on Warranty

(Utah) A written contract of sale contained a warranty providing that if after a trial of five days the machinery should fail to fulfill the warranty, written notice should be given to the seller and also the agent from whom the machinery was received, and that failure to make such trial or give such notices should be conclusive evidence of due fulfillment of warranty. Notice of breach of warranty was given to the agent, but not to the seller until nearly a year after the sale. Held, that as notice was a condition precedent to the reliance on the warranty, action for the price could not be defeated on the ground of breach of warranty, the notice to the agent not being enough.

Where a contract of sale required machinery found defective to be returned, a failure to return defective machinery precludes reliance on the warranty. *(Consolidated Wagon & Machine Co. v. Barben, 150 Pac. 953.)*

Moving Pulley Causes Injury

(Missouri) An employe holding a belt away from a moving pulley while coemployes shortened it was injured by having his arm drawn into the pulley. It was not customary to stop the machinery, and the employe had done this work for years without stopping the machinery, and was familiar with the work. The pulley was coated with some adhesive substance, which was nothing out of the ordinary, and it had flanges at the sides fastened by screws, but there was nothing to show that it was negligence to operate such a pulley. The operation was attended by some danger unless precaution was taken, and safer methods might have been employed by the employe and his coemployes in doing the work, but the employe made no request of any one in authority to stop any part of the machinery. Held, that the employer was not guilty of actionable negligence either in permitting the pulley to remain in motion or in failing to furnish safe place to work or safe appliances. *(Chandler v. St. Joseph Lead Co., 178 S. W. 217.)*

Unfair Competition in Sale of Tools

(Federal) Complainant invented an automobile tool for which he applied for a patent. Pending action on his application, he commenced manufacturing and through extensive demonstrations and advertising quickly created a market. Defendant then commenced making and selling the same tool, practically identical in form and appearance and also using complainant's cuts and other advertising matter. Held that, while defendant was within his legal rights in making the tool, his further acts in attempting to take the business complainant had built up constituted unfair competition, and therefore would be enjoined. *(Stewart v. Hudson, 222 Fed. 585.)*

Master Not Liable for Injuries

(Missouri) Where plaintiff's husband, employed by defendant to operate electrical machinery, was killed on Sunday, while at defendant's plant on a pleasure visit to show a new motor and the method of its operation to two friends, defendant was not liable for the death, since a master is not liable for injuries to his servant unless the latter was at the time in performance of some duty for which he was employed. *(Biddlecom v. Nelson Grain Co., 178 S. W. 750.)*

Failure to Inspect Machinery

(Kansas) One who, after contracting to buy an engine, subject to inspection, examines all of it except the firebox and omits to examine that because he could not do so without soiling his clothes, is not as a matter of law precluded from relying upon statements fraudulently made to him by the seller regarding its condition, or from making such statements the basis of a rescission of the contract for fraud. Whether a sufficient reason existed for omitting a complete inspection is a question of fact to be determined upon by a consideration of all the circumstances of the case.

Where a written contract for sale of machinery is complete, and covers the matter of warranty, the buyer cannot rely upon prior or contemporaneous oral representations of the seller as to the condition of the property as constituting a warranty. *(Aultman & Taylor Machinery Co. v. Schierkolk, 149 Pac. 680.)*

Inventions of Employes

(New York) The right of an employe to use exclusively a patent obtained while under contract of employment is discussed in Doscher v. Phelps Guardant Time Lock Co. "The doctrine that when a person in the employ of another in a certain line of work devises an improved method or instrument for doing that work, and uses the property of his employer and services of other employes to develop and put in practicable form his invention, and explicitly assents to the use by the employer of such invention, a jury or court trying the facts is warranted in finding that he has so far recognized the obligations of service flowing from his employment and the benefits resulting from his use of the property as to have given to such employer an irrevocable license to use such invention, is not applicable to the facts of this case, where the acts of the parties preclude any such finding. The work on the new patent did not interfere with, and was no part of, the duties of Phelps as general manager of the company, having been done outside of business hours. He himself paid the corporation for services rendered by its employes on his device when they had nothing else to do; and while the corporation incurred the obligation to pay for material in the construction of the new device pending the granting of the patent, and was authorized to sell the device to its customers, this was done to further the interests of the corporation, and with the view that when the patent was procured the patentee

would give the corporation the first opportunity to purchase it. Neither does the fiduciary relation of Phelps to the company, under the established facts, entitle the plaintiff to the relief demanded." *(Doscher v. Phelps Guardant Time Lock Co., 153 N. Y. S. 740.)*

New York Conditional Sales Law Held Not to Affect Interstate Commerce

(Federal) Where a monotype machine was sold by a Pennsylvania concern to a company in New York under the conditional sale plan, the New York law with relation to conditional sales must be strictly complied with, though the sale is one which has some evidence of being a transaction in interstate commerce. The United States Circuit Court of Appeals, Southern District of New York so held in Lanston Monotype Machine Co. v. Curtis.

One Curtis, a resident of New York City, purchased a monotype machine from the Lanston company, a Pennsylvania corporation. The sale was consummated in New York City and was conditional. Title was not to vest until the full purchase price had been paid which was $3240. Part of the purchase price was to be paid in advertising space in a journal of which Curtis was the editor. Curtis paid $1330 in cash and advertising and then defaulted. The monotype company took possession of the machine and made a resale, forgetting the provisions of the New York sales law which require that the vendor of goods sold on conditional sale must, on retaking the goods, hold them for thirty days giving the vendee an opportunity to perform the contract, and if he fails to do so sell the goods at public auction. Curtis brought suit to recover the $1330 alleging that the failure of the Lanston company to comply with the New York Sales law entitled him to the money which he had paid on the contract. On appeal, the United States Circuit Court of Appeals affirmed the holding, the court saying:

"We do not think the section of the personal property law relied upon by the defendant was a regulation of interstate commerce. No doubt it does indirectly affect such commerce, but it is in no sense a regulation of it. The purpose of the legislation is to protect the public against onerous and unreasonable contracts of conditional sale very likely to be misunderstood."

The contract having been executed in New York, and the monotype company not having exercised its right to cancel, the same is in our opinion a New York contract, to be governed by the law of that state. The parties evidently contracted with reference to the law of New York. The machinery was to be used there, and paid for there, and in case of the purchaser's default the remedies of the vendor were to be availed of there. Hence, when the monotype company retook the chattels, it did so subject to the provisions of the New York law regulating conditional sales. *(Lanston Monotype Machine Co. v. Curtis, 224 Fed. 405.)*

Machinery Subject to Lien

(Federal) The Ohio Code gives every person who furnishes machinery for altering a manufactory by virtue of any contract with the owner or lessee of the premises upon which the manufactory is situated, a lien to secure payment for the labor and machinery furnished. The law also provides that where machinery is furnished on leased lands, the leasehold shall be subject to the lien. Under this law a petition was filed in the case of E. A. Kinsey Co. v. Heckerman, trustee in bankruptcy, to establish a lien on certain machinery sold to the bankrupt James L. Patton. The Kinsey Co. had sold two wire-feed screw machines to the bankrupt, and the trustee in bankruptcy had refused to allow a lien on the machines asserting that the machines were not furnished for the purpose of "altering a manufactory" as prescribed in the law. The trustee in his report claimed that the machines were merely an addition to the equipment of the manufactory. The matter was taken to the United States Circuit Court of Appeals where the court held the installation of the machines to constitute the "alteration of a manufactory." *(E. A. Kinsey Co. v. Heckerman, 224 Fed. 313.)*

Injured in Starting Engine

(Federal) Where plaintiff was injured in trying to start a well-pumping engine, after he had oiled it, because the throttle allowed steam to leak into the cylinder, so that when he moved the engine from dead center it started suddenly he was entitled to damages for the injury irrespective of the fact that the owner of the machine believed the machine to be safe and had taken precaution to insure its safe condition. *(Gillespie v. Collier, 224 Fed. 299.)*

* * *

PUNCTUALITY

BY J. P. BROPHY*

There is no word in the English language that receives as much abuse as the word punctuality, and what is the reason? Weakness of human nature. Punctuality is a beautiful thing to talk and think about because it means so much when lived up to, but instead of being punctual thousands of people are merely procrastinators.

Time is everything to the individual who works his brain intelligently, either from the standpoint of pleasure or business, but the man who promises to meet you promptly at ten o'clock and wilfully forgets to do so or fails to keep his word, but hurriedly meets you at 10:30, giving flimsy excuses, is not in a class claiming punctuality. Such a person forgets that he is wasting your valuable time.

The meaning of this word punctuality is not to be considered along the lines of ordinary promises. Its meaning is far-reaching and extends deeply into the business world. When negotiating on any kind of deal, there is always a time named for doing things. The punctual business man is exceptionally careful not to overestimate his ability in naming a time in which any line of goods may be delivered. Not being punctual in many cases leads to serious misunderstandings and loss of business.

It is a source of great satisfaction to deal with an individual who is punctual, but the man who is constantly making promises which you know positively are not going to be kept is in many instances avoided. All this means that punctuality in all walks of life is a considerable asset.

To class an individual as a prevaricator is putting it strong, but a man who is not punctual is getting pretty close to that class. There is nothing so exasperating in the world as a promise broken. It leads to many annoyances in all directions, and very often prevents the performance of duties that should be taken care of. To say that you are going to do a thing at a certain time, knowing that you are not going to do it, means that you are in a class that should be avoided.

In the business world a common expression is: "We will have such and such a thing shipped in about ten days". This seems to be the first thing that enters any number of people's minds. Ten days seems to be an easy expression. The one to whom you say it, if he is not sure whether you mean it or not, is relying on these ten days, whereas you may be absolutely sure that it will be about twenty. This is where the word punctuality is abused in the extreme.

A really punctual person is admirable. You know that he means just what he says and will live up to his word. The man who is not punctual is an abuser of time; he is indifferent through his genuine selfishness. He cares nothing for the inconvenience of the one he is to meet or do business with in any form. He is thinking only of himself.

No doubt many promises that are made are intended to be kept, but something occurs that makes it impossible to keep them; however, the number of times that this happens is insignificant compared with the number of times the word punctuality is a misnomer. From a business standpoint, the false promiser is to be abhorred. He is dangerous in every way and will be shunned because of being an inveterate truth dodger, which creates disorder in business and otherwise.

The man who never discovers his own weakness as a promiser, who never sincerely means to qualify as dependable in either a social or business way is a menace, and this applies to both men and women.

* Vice-president and general manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

METALS USED IN THE MANUFACTURE OF WAR MUNITIONS*

RESOURCES OF THE TWO SIDES IN THE WAR

In this article H. C. H. Carpenter attempts to compare briefly the resources of the Allies and of the Teutonic combination in respect to the metals which are essential for war purposes.

The most important metal is iron, the basis of the steel which is used in a multitude of ways. Both sides can show abundant resources of iron ore and of the plants necessary to produce the metal. The Teutonic deposits, however, would appear to be of lower grade from the fact that Germany makes 96 per cent of her steel in basic-lined furnaces and England only 36 per cent.

For shrapnel and high-explosive shell casings, open-hearth steel is used, and to make this from pig iron requires the addition of manganese. Thus manganese is very important; it is used in the form of spiegeleisen or of ferro-manganese to deoxidize the steel and to leave a small percentage in the finished product. Manganese producers in the order of their importance are Russia, India and the United States. In 1913 Germany imported about 670,000 tons of high-grade ore, chiefly from Russia, six or seven times her domestic production including Austria-Hungary. It is unlikely, however, that the shutting off of outside supplies will hamper her. Manganese is wide-spread in nature and while many deposits remain unworked because more valuable ones are available, in times of stress these could furnish large quantities of lower-grade ores. Germany could thus supply herself, and her metallurgists could easily solve the problem of handling the poorer material; it seems probable also that she had accumulated stores previous to the outbreak of the war, and she may be able to discover substitutes.

Nickel is an indispensable constituent of gun and armor-plate steel, as well as of the modern bullet and armor-piercing projectile. It is doubtful whether any satisfactory substitute could be found. The Canadian mines produce about 85 per cent of the world's supply, most of it refined in the United States, some in South Wales; New Caledonia supplies the balance except a little from Norway. Fully 98.5 per cent was produced in the allied countries before the war.

Nickel ores occur in the Teutonic countries and could furnish some metal, but they would be inadequate for the needs of Germany even if she gets the 400 tons produced by Norway. For in the first half of 1913 she imported almost 7000 tons of ore and 3500 tons of metal, while her exports were only 2409 tons of metal for the entire year.

Chromium is almost as important as nickel, being an essential constituent of armor plate and armor-piercing projectiles. Most of it has come from Rhodesia and New Caledonia, some from Russia and some from Greece and Asia Minor, the production of the last two countries having declined lately. It is likely, however, that Germany could obtain all she needed from Asia Minor even if Greece should join the Allies.

Copper is of prime importance in the manufacture of munitions of war. All shells are fitted with a copper band to expand into the rifling, thus stopping the passage of the gases, effecting the rotation of the shell and keeping the shell itself from contact with the gun barrel. Before the war, some zinc was used with the copper to lower the cost, but with zinc selling higher than copper this is no longer necessary. Copper is also used in cartridge cases, in shell fuse-heads and in Admiralty gun-metal and high-tension hydraulic bronze.

Of the world's output, about a million tons, the United States produces over half, Germany and Austria-Hungary about 3 per cent. All the belligerent countries except Japan imported from the United States. The Allies have obtained copper at will since the war began, while their enemies have been in straits. The latter have probably received a good deal through neutral countries, but their own production being only about 10 per cent of their peace consumption, it is certain that the use of copper is being restricted to purposes for which it is essential. Reserves must be greatly depleted and all producing plants worked to their utmost capacity, while strong efforts are being made to develop substitutes.

The use of aluminum has received a great impetus from its suitability for the construction of air craft. It is also valuable as an explosive. "Ammonal" consists of ammonium nitrate and finely divided aluminum. It is a disruptive explosive not suitable for propulsion but excellent for filling explosive shells. The United States and Canada have produced about half of the world's supply, the rest coming from France, England and Switzerland. The latter is available for Germany and Germany herself has become a producer, but the Allies, especially in view of the bauxite deposits of France, are in a far stronger position.

The five-fold advance in the price of zinc has been one of the most spectacular events of the war. Germany has heretofore smelted large quantities, drawn largely from Australia, but there are available supplies within the Teutonic boundaries. Great Britain is experiencing a shortage, due to inadequate smelting works, and has to draw upon the United States for most of her supply. Zinc as a constituent of brass is used in cartridge cases, and also for galvanizing barbed wire.

As for lead, Germany is a large producer, while the Allies draw most of their supplies from the United States, Mexico and Spain. Lead is used for bullets, the shrapnel bullet being a lead-antimony alloy. Antimony has advanced in price as has zinc; most of it comes from China.

Tin is used in bearing metals, various solders, tin plate and gun-metal. The ores come from the Straits Settlements and Bolivia chiefly. England has smelted a good deal. The Teutonic countries have heretofore relied upon imported ores for their supply and their domestic resources are inadequate.

It appears then that of the ten leading munition metals, Germany and her allies can produce five without recourse to imports, namely, iron, manganese, chromium, zinc and lead. It is questionable whether they could supply themselves with nickel, copper, aluminum, tin and antimony from their domestic deposits. It is reasonably certain, however, that before the war, they had laid in large stocks of these metals or their ores and that a very long war indeed would be required to exhaust them, while in that event it is a safe conclusion that their metallurgists will have been employed in the discovery of substitutes for the metals likely to run low. The Allies need have no fear of a shortage in any direction except that zinc may be scarce for a while.

* Abstract of article that appeared in "Nature."

* * *

MONTHLY MEETING OF THE A. S. M. E.

The October monthly meeting of the American Society of Mechanical Engineers was held Tuesday evening, October 12, in the Engineering Societies Bldg., New York City. A paper had been prepared by Frank B. Gilbreth on "Motion Study for Crippled Soldiers," but Mr. Gilbreth was unable to present it owing to illness, and the paper was read by Robert T. Kent, a member of the society. In his paper, which was illustrated with lantern slides, Mr. Gilbreth stated that there are already two million men in Europe who have suffered the loss of limbs, faculties, or both as a result of injury in the war. The study of adapting these crippled men to machines for manufacturing operations or of redesigning machines to fit the men is a problem which will have to be solved in the near future. The lantern slides showed the use of the chronocyclegraph, micromotion and simultaneous cycle chart. The motions of the worker are photographed in such a way that they can be followed in a time sequence. By a study of these various motions in every sort of occupation, Mr. Gilbreth believes that the cripples may be utilized in many occupations in which, without the advantage of these special studies, they would be useless. In order to make headway with the crippled soldiers' problem, there must be general cooperation, and Mr. Gilbreth pointed to the need of photographs, records and histories of cases where cripples have been trained to do work that is usually performed successfully only by men in full possession of their limbs and faculties.

WAGES AND HOURS OF LABOR

U. S. Department of Labor, Bureau of Labor Statistics, reports that the highest wage scale per hour paid in May, 1914, in a few of the principal trades were as follows: bricklayers 87.5 cents, in Dallas and San Francisco; carpenters 65 cents, in Chicago; hod carriers 50 cents, in Portland, St. Louis, Salt Lake City and San Francisco; painters 70 cents, in Chicago; plasterers 87.5 cents, in Dallas and San Francisco; plumbers and gas fitters 75 cents, in Chicago, Dallas, Portland, St. Louis, Salt Lake City, San Francisco and Seattle; sheet-metal workers 68.8 cents, in Chicago and San Francisco; stonecutters 70 cents, in Portland and San Francisco; structural iron workers 70 cents, in Cleveland; freight handlers 60.6 cents, in New Orleans; granite cutters 68.8 cents, in New York; iron molders 50 cents, in San Francisco; linotype operators (Hebrew book and job) 83.3 cents, in New York; compositors (English newspaper) day work 75 cents, in Seattle. The building trades in the majority have an eight-hour day and most building trades also have a Saturday half holiday either for the whole year or part of the year. Inside wiremen, lathers, marble setters, fresco painters, sign painters, structural ironworkers and the granite and stone trades all have an eight-hour day in the cities reported and nearly all have a Saturday half holiday the year round. The hours of labor range from forty-four to sixty per week, fifty-four being the predominant number of hours. The printing trade and job offices in nearly all the cities covered and in the newspaper offices have an eight-hour day or less.

* * *

CALCIUM CARBONATE—NOT CALCIUM CARBIDE

Allow me to make a correction in the article on oxy-acetylene welding and cutting in the October number. It was stated on page 90 that in purifying air for the manufacture of oxygen by the liquid air method the air is drawn through a pit containing lime which absorbs the carbon dioxide by chemical reaction, resulting in the formation of calcium carbide. This is an error; calcium carbonate is the result, as shown by the following: Common quick-lime is CaH_2O_2 and carbon dioxide is CO_2; hence $CaH_2O_2 + CO_2 = CaCO_3 + H_2O$, and $CaCO_3$ is known as calcium carbonate and not as calcium carbide. G. B. M.

* * *

THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The fourteenth annual convention of the National Machine Tool Builders' Association was held in New York City at the Hotel Astor, October 28-29. President W. A. Viall of the Brown & Sharpe Mfg. Co. presided. On account of the abnormal conditions produced by the huge war orders and widespread labor troubles the executive sessions took up the large part of the time. The usual meetings of the lathe, planer, drilling machine and other machine tool committees were held, in which the state of business in the individual lines represented, was discussed in detail. Charles Meigs Ripley addressed the members in open meeting on power and lighting plants.

* * *

U. S. Civil Service examinations will be held November 2 in Washington, D. C., Chattanooga, Tenn., Kansas City, Mo., and San Francisco, Cal., for the following positions: Senior electrical engineer, senior signal engineer, senior telegraph and telephone engineer, senior architect and senior structural engineer. The salaries of all these positions range from $1800 to $2700 a year.

* * *

QUOTATIONS OF WHOLESALE METAL PRICES

Week Ending October 22

Aluminum, pig, per pound, ton lots	$ 0.55
Antimony, Asiatic, per pound	0.29
Black sheets, No. 28, per 100 pounds, Pittsburgh	2.00
Copper, electrolytic, per pound	0.17¾
Copper, lake, per pound, New York	0.17¾
Galvanized sheets, No. 28, per 100 pounds, Pittsburgh	3.50
Iron bars, refined, per 100 pounds, Pittsburgh	1.40
Iron, pig, foundry No. 2, per ton, Philadelphia	16.25
Iron, pig, basic, valley furnace, per ton	15.00
Iron, pig, Bessemer, per ton, Pittsburgh	16.95
Iron, pig, gray forge, per ton, Pittsburgh	14.70
Lead, per 100 pounds, New York	4.50
Nails, cut, per 100 pounds, Pittsburgh	1.70
Nails, steel wire, per 100 pounds, Pittsburgh	1.80
Spelter, per pound, New York	0.13⅝
Steel angles, per 100 pounds, Pittsburgh	1.45
Steel bars, per 100 pounds, Pittsburgh	1.45
Steel beams, per 100 pounds, Pittsburgh	1.45
Steel billets, forging, per ton, Pittsburgh	34.50
Steel rails, per ton, at mill	28.00
Steel tank plates, per 100 pounds, Pittsburgh	1.45
Tin, per pound, New York	0.33⅝
Tin plate, per 100-pound box, New York	3.39
Wire, barbed, galvanized, per 100 pounds, Pittsburgh	2.70

The foregoing metal prices quoted are nominal, especially in the steel trade. The enormous demand for steel bars used in the manufacture of shrapnel and high-explosive shells has resulted in flooding the steel mills with orders, and while $1.45 per hundred pounds is the price fixed by the Carnegie Steel Co. for steel bars, large rounds are actually quoted at from $3 to $3.25 for quick delivery. The steel mills are months behind in deliveries, and at the present rate of order-taking their full capacity for 1916 will have been contracted for before the end of the present year. Brass is practically unobtainable in large quantities for early delivery. The railways, having postponed orders for equipment greatly needed a year or two ago when the mills were begging for business, now find themselves swamped with freight and unable to get quickly the rails and cars required to replace worn-out track and rolling stock. Heavy foreign demands for rails, bars and billets have forced prices up abnormally. Forging billets that ordinarily sell for $26 a ton have sold as high as $56 a ton.

* * *

PERSONALS

L. A. Perris, importer and exporter, New York City, has removed his office from 80 Wall St. to 24 State St., where he has associated himself with the Warehouse Mercantile Co.

Robert Allan has been appointed district branch manager for northern California by the Burd High Compression Ring Co. His headquarters will be 847 Phelan Bldg., San Francisco.

E. Ashton has been transferred from the Canadian plant of the United Shoe Machinery Co. at Montreal, to the Beverly, Mass., plant, and is succeeded by C. W. Miess, as chief tool designer.

W. L. Wright has resigned the position of vice-president of the Keystone Watch Case Co. to take the position of vice-president of Driggs-Seabury Ordnance Co., Sharon, Pa., with offices at 50 Church St., New York City.

C. A. Bennett, foreign representative of the Fellows Gear Shaper Co., Springfield, Vt., has returned to England to take up the work there. Mr. Bennett made his headquarters in Paris, France, before the outbreak of the war.

Frank O. Hoagland, works manager of the Union Metallic Cartridge Co., Bridgeport, Conn., has resigned the position to become assistant to B. M. W. Hanson, vice-president and works manager of the Pratt & Whitney Co., Hartford, Conn.

E. P. Tuinhout, representative of Van Rietschoten & Houwens, Rotterdam, Holland, importers of American machinery, is in the United States on a six weeks' business trip for the purpose of securing agencies for American machine tools, woodworking machinery, box machinery, etc. His headquarters while in the United States will be MACHINERY's office, to which mail may be addressed.

* * *

OBITUARIES

Capt. John J. Knapp, commandant of the Philadelphia Navy Yard, died at the Naval Hospital in Philadelphia, September 28, of apoplexy, aged fifty-eight years.

Augustus J. Dubois for years professor of civil engineering in the Sheffield Scientific School, Yale University, died of heart failure, October 19, at his home in New Haven, Conn., aged sixty-six years. Prof. Dubois was widely known as a writer on engineering subjects.

Frederick J. Chisholm died in New York September 25, following a long illness, aged forty-one. Mr. Chisholm was an electrical engineer, and for a number of years represented the Allis-Chalmers Co. in the West and later the General Electric Co. in New York City.

Thomas Pattison, for more than fifty years a well-known railroad man in Western Massachusetts, died at his home in West Springfield, September 27, aged eighty-three years. He retired from the Boston & Albany R. R. shops in 1896 after a continuous service of forty-two years, during which time he assisted in building 137 locomotives.